BARITE HILL PROJECT
MAIN PIT
CLOSURE REPORT

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1.0 INTRODUCTION

1.1 Scope

This report presents the operational procedures proposed for closure of the Main Pit at the Barite Hill Project. The general arrangement of facilities at Barite Hill is shown on Figure 1.1. Pit closure will involve partial backfill with stockpiled waste rock and placement of a clay cover over backfill and exposed pit walls. Following closure, the pit will be established and a free draining depression. The objectives of closure are to control oxidation and acid generation in backfill and pit walls in the long term, to establish and maintain acceptable post closure groundwater and surface water quality conditions, and to construct a stable vegetated cover over the pit.

A discussion of the site inspection, field and laboratory testing, and a hydrogeologic evaluation conducted in support of closure plan development is provided in the following sections. Based on the results of these investigations, the operational procedures proposed for pit closure are presented. A post-closure monitoring plan and contingency measures are also provided.

1.2 Background

Mining at the Barite Hill Project, located near McCormick, South Carolina, commenced in 1990. Mining in the Main Pit was halted in 1994. During the later stages of the mining operation, approximately 160,000 cubic yards of sulfide (pyrite) bearing waste rock encountered in the main pit were placed in a temporary stockpile adjacent to the pit. Since mining operations were terminated, the pit has begun to refill and currently contains approximately 57 million gallons of water.

The stockpiled sulfide waste rock and sulfide bearing pit wall exposures exhibit acid generating conditions as a result of pyrite oxidation. The water contained in the pit is currently of low pH reflecting interaction with exposed pit wall sulfides and previously backfilled waste rock, and accumulation of acid products in runoff from the stockpiled waste rock and pit walls.

2.0 OVERVIEW OF CLOSURE ACTIVITIES

The primary objective of the Main Pit closure and reclamation is to mitigate acid rock drainage from stockpiled backfill and pit walls and create acceptable long-term water quality conditions. The general sequence of events that will be undertaken to close the Main Pit are summarized as follows:

- The pit water will be pretreated to neutralize acidity and control ongoing oxidation;

- The volume of water contained in the pit will be reduced by establishing a spray evaporation system. The pit water volume will be reduced to that required to occupy the void space in the stockpiled backfill;

- During pit water volume reduction and prior to placement of the backfill, the pit water will be periodically treated, as required, to produce or maintain alkaline conditions and limit metal solubility;

- Following pit water volume reduction, the existing waste rock stockpiles will be treated with base additives and placed in the pit beneath the post closure groundwater level. Treatment of the waste rock backfill will be to a level required to neutralize acidity contained in the backfill and limit adverse impacts to pit water quality from backfill placement;

- The pit walls will be regraded to a maximum 3H:1V slope by a combination of cast blasting and ripping. Additional material derived from pit slope reduction will be used as clay for the soil cover system, or will be used as additional backfill material;

- A drainage cut will be excavated in the north end of the pit above the anticipated post closure groundwater level. The pit will be graded to drain through the post closure cut. No surface water will be impounded in the pit following closure. Surface runoff from the pit cover will be discharged to an existing natural drainage; and

- The post closure pit configuration will be covered with a low permeability soil cover and growth media, and revegetated to produce a stable, nonerodible layer.

In the short term, maintenance of water quality will be undertaken by pretreating pit water and waste rock backfill. Pretreatment of pit water will be undertaken to control ongoing oxidation, and precipitate metals and dissolved solids prior to volume reduction to control scale formation in the spray evaporation system.

Field and laboratory testing indicates that the waste rock backfill contains readily leachable oxidation products (acidity, sulfate and dissolved metals) that will be available to interact with the pit water during backfilling operations. Amendment of the backfill with base additives to neutralize available acidity is proposed as a means of maintaining acceptable pit water quality during backfill operations.

Mitigation of acid generation in the long term will be affected by the subaqueous placement of stockpiled acid generating sulfide waste rock beneath the post closure groundwater level. Oxidation of pit wall rock will be controlled by the placement of fine grained soil cover that will reduce infiltration. In addition, the fine grained low permeability soil cover material will have a high moisture retention capacity and will limit the diffusion of oxygen into the underlying backfill and pit walls, thereby limiting oxidation.

To facilitate closure, a reduction in the quantity of water currently contained in the Main Pit is necessary prior to placement of the backfill. The volume of pit water will be reduced by evaporation to the amount that will be required to fill the void space in the stockpiled sulfide waste rock backfill. As such, the stockpiled waste rock backfill will be submerged upon placement and at the completion of waste rock backfill, the pit will be free of excess water and conditions suitable for construction of the soil cover will be developed. Long-term impact to local groundwater resources is not expected under these closure conditions.

3.0 SITE INSPECTION

Steffen Robertson and Kirsten (U.S.) Inc. (SRK) visited the Barite Hill site on May 31 and June 1, 1995 to conduct an evaluation of pit closure alternatives. While on site, a survey of the backfill and pit wall areas was conducted.

3.1 Stockpiled Backfill

The material proposed for pit backfill below the post closure pit water level was examined. Two material types were identified that consist of a blocky, siliceous dark gray schist, and a partially oxidized gray to gray green schist exhibiting slatey cleavage. The former is oxidized to a limited degree and constitutes the bulk of the material stockpiled for future backfill. The latter represents less that 10 percent of the stockpiled backfill.

To evaluate the backfill, a series of field paste pH and paste total dissolved solids (TDS) tests was conducted. These tests involved mixing approximately equal portions of solids and deionized water and measuring the pH and TDS content of the paste following agitation. The tests are used to estimate the stage or existence of acid generation and the presence of potentially leachable acid products (acidity, metals and salts).

All testing of backfill material indicated paste pH values in the range of 1.9 to 2.3 and paste TDS content greater than 2000 ppm. The tests indicate conditions favorable for advanced, biologically catalyzed oxidation of the backfill and high TDS content indicates storage of leachable oxidation products.

Runoff and seepage from the waste backfill area on the pit haulage ramp exhibited a pH of 1.5 and a TDS content of greater than 2000 ppm.

3.2 Pit Wall Areas

In conjunction with survey of the proposed backfill material, field paste testing was conducted at several locations on the 395 bench where sulfide bearing rocks are exposed on the pit walls. Field testing of the exposed sulfide bearing wall rock indicated low pH (0.9 to 1.9) and high TDS content. These test results indicate an advanced rate of oxidation in exposed pit wall sulfides and the presence of leachable acid products.

3.3 Clay Borrow Area of Main Pit

Several samples of the clay borrow material were also examined. The clay exhibited paste pH values near 4.3 and paste TDS content in the range of 30 to 90 ppm. The low TDS content indicates that the clay does not contain stored oxidation products and would not be anticipated to have a significant readily leachable metal or salt content. Surface water runoff collected in the clay borrow area exhibited a pH of 4.3 and a TDS content of 30 to 140 ppm. These results appear to confirm that the leachable content of the clay borrow material is low.

3.4 Pit Water

3.4.1 Water Quality

At the time of the site inspection, the field measurements indicated a pit water pH of 2.2 and a TDS content of greater than 2000 ppm. Pit water analyses for samples collected in March and June of 1995 are contained in Appendix A. Selected data are summarized in Table 2.1.

Laboratory analysis of the June 1995 sample indicated a TDS content of 3070 mg/L and sulfate content at 2390 mg/L. Metals present in significant concentrations include aluminum (14.6 mg/L), cadmium (1.15 mg/L), calcium (66.7 mg/L), copper (24.9 mg/L), iron (57.5 mg/L), manganese (5.67 mg/L), zinc (15.5 mg/L) and selenium (1.35 mg/L). Traces of barium, lead and nickel were also detected. Sodium concentration was 572 mg/L and chloride content was 208 mg/L.

In June, a laboratory pH value of 7.2 was reported for the pit water. Field measurements of pit water indicated a pH near 2.0. A bulk pit water sample received from Barite Hill in July 1995 had a pH of 3.4. A split from the bulk sample submitted to an outside analytical laboratory exhibited an acidity of 447 mg/L. Therefore, based on the field testing and supplemental analysis of the bulk pit water sample, the June 1995 laboratory pH value is considered to be in error.

Comparison of June 1995 to March 1995 data (Appendix A) indicates increasing trends in the concentrations of TDS and sulfate. Aluminum and iron exhibited marked increases in concentration in June while copper concentration decreased.

In March 1995, the laboratory pH value for the pit water was 5.9 while alkalinity occurred at a concentration of 11.7 to 16.2 mg/L. The absence of alkalinity in the June sample and the reduction in pH exhibited from March to July suggests ongoing oxidation of the pit walls and stockpiled backfill, and the accumulation of acid products affecting the pit water quality.

3.4.2 Pit Volume

The height versus capacity relationship for the main pit is shown in Appendix B. The height versus capacity relationship was developed from Barite Hill's final pit topography survey and was corrected for previously placed backfill. Pit water elevations were estimated by comparing photographs taken in June and September, 1995 to features recognizable on the pit topography map.

During the June 1995 site visit, the pit water level was approximately 385 feet and contained an estimated 24.7 million gallons. In the period between June and September 1995, the water level rose to an elevation of approximately 388 feet corresponding to an estimated volume of 29.3 million gallons. The most recent pit survey, conducted in May 1996, indicates the water level at approximately 402 ft, corresponding to a pit water volume of approximately 57 million gallons.

4.0 FIELD AND LABORATORY TESTING

4.1 General

Bench scale base addition tests were conducted on a pit water sample provided by Barite Hill in July 1995 and on a bulk waste rock sample collected by SRK during the June, 1995 site visit. An on-site test was conducted to determine the bulk porosity of the waste rock backfill and its leachable content of acidity.

Pretreatment of the existing pit water, and amendment of backfill to neutralize available acidity and control metal solubility will be required to create acceptable groundwater quality conditions in the post closure pit. A survey was conducted to identify locally available materials that could be used for pit water and waste rock treatment.

The following materials were identified:

- Slaked lime (produced as a by-product of acetylene manufacturing) from the SUNOX gas plant located in Blythewood, S.C.;
- Cement kiln dust produced by Giant Cement Corp., Harleyvillle, S.C.;
- Raw phosphate rock and processed phosphate rock from PCS Phosphate of Aurora, N.C.,
- Crushed limestone from Martin Marietta's Berkeley quarry in Eutawville, S.C.; and
- Crushed dolomitic limestone from Vulcan materials in Blacksburg, S.C..

In addition to the above raw materials and industrial waste by-products, the processed reagents sodium hydroxide (NaOH) and trisodium phosphate dodecahydrate (TSP, $NaPO_4 \bullet 12H_2O$) were also identified as potential candidates for pit water pretreatment and waste rock amendment.

Samples of the materials were obtained from the manufacturers/producers and used in a series of bench tests to determine their ability to neutralize waste rock and pit water and enable estimation of addition rates. Amendment testing is discussed in the following sections.

4.2 Test Procedures

4.2.1 Pit Water Pretreatment Tests

Pit water pretreatment tests were conducted by adding the identified amendments to a one-liter sample of water and monitoring the pH of the treated sample. Two criteria were used to estimate base addition rates.

Compounds such as lime and caustic (NaOH) are used in water treatment to elevate pH and reduce metal concentrations by precipitating metal hydroxides. Previous experience has shown that a pH of 7.0 or above is required to affect a reduction in metal concentration if lime and caustic are used. Therefore, a treatment pH endpoint near 7.0 was assumed for estimation of base addition rates in tests utilizing NaOH, slaked lime, dolomite, limestone and lime kiln dust.

The addition of phosphate compounds to low pH waters containing elevated metal concentration results in an increase in pH and in the precipitation of metal orthphosphates in the form of MPO_4 or $M_3(PO_4)_2$ where "M" represents the metal. Most commonly occurring metals will react with phosphate to form orthophosphates that are insoluble in alkaline solutions. Experience with phosphate treatment indicates the selective precipitation of iron, copper, manganese and zinc occurs at a pH near 5.0. Further addition of phosphate and elevation of pH results in the precipitation of calcium orthophosphate. Therefore, in pretreatment tests with phosphate rock and TSP, a treatment endpoint pH of 5.5 was assumed for determination of addition rates.

Under field conditions, the ability to mix base additives with the pit water will be limited, particularly for the case of sparingly soluble additives such as limestone and dolomite. Therefore, additives were placed in the pit water samples without physical mixing or agitation to simulate field conditions in a "contact" test.

In a trial and error approach, base materials were added to pit water samples in sufficient quantity to produce the target pH endpoint. The time required for each additive to produce the desired endpoint was also noted to determine their relative reactivity. For materials which reacted rapidly with the pit water, treated water samples were decanted and shipped to an outside laboratory for analysis of selected constituents (constituents that occur in the pit water).

4.2.2 Waste Rock Neutralization Tests

A series of bench tests was conducted to evaluate the base addition rates that will be required to neutralize available acidity in the backfill. The tests involved mixing each of the identified additives with a 300 mg sample of waste rock backfill. The samples were then submerged in deionized water and the pH of the pore water and time required to reach the target pH endpoint was monitored. To determine pH, the sample containers were tilted and a pH probe was inserted in standing surface water. The pH endpoints discussed in Section 4.2.1 for phosphate and non-phosphate compounds were assumed for estimation of waste rock base addition requirements.

By trial and error, the minimum addition rates for each additive were determined using 300 mg backfill samples. For each additive that was indicated to be effective, a second test was conducted with a 2 kg sample and a similar addition rate. For materials that reacted relatively rapidly to neutralize the waste rock, upon achievement of the desired pH endpoint the pore fluid was drained from the sample and submitted to an outside analytical laboratory for analysis of selected constituents.

Following submergence of the samples, additional mixing or agitation was not undertaken. This procedure was adopted in order to simulate field placement of the backfill in the open pit where, following placement and submergence, additional mixing or agitation will not be possible.

4.2.3 On-site Testing of Bulk Waste Rock Properties

In order to determine the bulk porosity of the waste rock backfill and estimate pit water reduction requirements, a field test of the backfill was conducted. A test pit was excavated and lined with PVC membrane. The quantity of water required to fill the pit was first measured to determined the volume of the test pit. The pit was then drained, filled with backfill material and the quantity of water required to fill the void space in the backfill was measured. The backfill was placed at its ambient moisture content, therefore, the measured porosity represents a residual or available porosity.

It is anticipated that the backfill will be placed in the main pit by dozer spreading and grading or by direct placement in the pit water. This method of backfilling will result in a light to moderate degree of compaction, Therefore, the sulfide waste rock was subjected to light compaction during placement in the test pit to simulate the anticipated density of the in-pit backfill.

The pH and TDS content of the backfill pore water were monitored until equilibrium conditions were achieved. A sample of the pore water was collected after equilibration for measurement of available acidity.

4.3 Test Results

4.3.1 Pit Water Pretreatment Tests

Table 4.1 summarizes the results of the pit water pretreatment tests. Laboratory data sheets are contained in Appendix C. Based on the fast rate of reaction indicated in the bench pretreatment tests, pit water samples treated with TSP, NaOH, slaked lime and kiln dust were submitted for laboratory analysis of selected constituents.

Laboratory pH in treated samples varied significantly from the pH endpoint targets of 5.5 for phosphate compounds and 7.0 for the slaked lime, NaOH and kiln dust. These data indicate that the reactions may not have been complete at the time of sampling.

4.3.1.1 TSP Treatment

TSP treatment to a pH of 6.0 indicates good reduction of Al, Ba, Cd, Cu, Fe and Zn when compared to the July 1995 pit water quality data. TSP had little or no affect on the concentrations of Mn, Se and Ni, indicating selective precipitation of the former group of metals at sub-neutral pH. The excess phosphate in the TSP treated solution was low (17.3 mg/L). The addition of more TSP and a further increase in pH can be anticipated to reduce metal concentrations by precipitating additional orthophosphates.

The dominant constituent in the pit water is sulfate which accounts for approximately 60 to 75 percent of the TDS content. The TDS and sulfate concentrations in the TSP treated sample are similar to concentrations measured in the July 1995 pit water sample. TSP treatment has no significant affect on sulfate concentration.

4.3.1.2 NaOH Treatment

With the exception of Ni, Cu, Mn and Zn, pit water treated to a pH of 8.6 with NaOH and TSP exhibit similar metal concentrations. Cu concentration was reduced to 3.55 mg/L (from approximately 25 mg/L in the July 1995 pit water sample), a slight increase over TSP treatment, Mn concentration was unaffected by NaOH treatment and Zn exhibited a further decrease in concentration over TSP treatment. Ni exhibited the lowest concentration in NaOH treated water. NaOH treatment had little affect on sulfate concentration.

4.3.1.3 Slaked Lime Treatment

Slaked lime treatment to a pH of 11.1, with the exception of calcium, produced the lowest overall concentration of metals. The lowest concentrations of Cd, Fe, Mn, Se and Zn were produced. A reduction in sulfate concentration also occurred as a result of gypsum precipitation. The slaked lime treated water exhibited excess alkalinity as carbonate (40 mg/L) and as hydroxide at a concentration of 101 mg/L.

4.3.1.4 Kiln Dust Treatment

In comparison to the other compounds, kiln dust was relatively slow in reacting. At an addition rate of 15 grams per liter, a pH of 6.5 was achieved after more than one week of contact. At this pH level, kiln dust was less effective in reducing concentrations of Fe, Mn and Zn. Treatment to a higher pH would be anticipated to have effects that are similar to slaked lime treatment. As kiln dust contain calcium, a reduction in sulfate concentration was realized due to the precipitation of gypsum.

4.3.2 Waste Rock Neutralization Tests

The results of the analysis of treated waste rock sample pore water extracts are summarized in Table 4.2. Laboratory data is contained in Appendix C. Laboratory pH values again differ from the target pH endpoint values suggesting either continued reaction following pore water extraction and during sample transport, or addition of insufficient base additive to achieve the desired pH target value.

4.3.2.1 TSP Waste Rock Treatment

TSP addition at a rate of 4.5 percent by weight produced waste rock pore water with a pH of 7.6 based on outside laboratory measurement. The TSP treated sample extract exhibited a TDS content of 52,300 ppm and sulfate concentration of 35,300 mg/L. In contrast, the TDS content in the pore water from the on-site waste rock test (Section 4.3.3) was 86,000 ppm. The addition of TSP, in relation to treatment with calcium containing additives, appears to have minor effect on TDS content.

4.3.2.2 NaOH Waste Rock Treatment

Addition of NaOH to a waste rock sample at a rate of approximately 1.3 percent by weight produced a pore water extract with a laboratory measured pH of 6.3. At this pH level, aluminum occurred at 13.6 mg/L, barium occurred at 1.19 mg/L, copper occurred at 1.66 mg/L, iron occurred at 44.4 mg/L, and the concentrations of manganese and zinc were 6.24 and 16 mg/L, respectively. All other measured metals were detected in concentrations of less that 1 mg/L.

The TDS content of the treated sample extract was 67,200 mg/L and in comparison to the on-site test (86,000 mg/L), indicates a slight reduction.

4.3.2.3 Waste Rock Treatment with Slaked Lime

Addition of slaked lime at a rate of 2.8 percent by weight produced a treated sample extract with a laboratory measured pH of 5.5. In comparison to NaOH treatment, increases in aluminum (at 26.1 mg/L), copper (at 3.38 mg/L) iron (at 99.7 mg/L) and zinc (at 22.6 mg/L) were measured in the treated sample extract. Calcium concentration was also increased. For other metals, concentrations are similar in the NaOH and slaked lime treated extracts. As shown by slaked lime neutralization of pit water, it is anticipated that neutralizing the residual acidity (195 mg/L) and increasing pH with additional lime would substantially reduce metal concentrations.

Slaked lime addition produced a significant decrease in the TDS content. Sulfate concentration was 3900 mg/L, approximately 10 percent of the sulfate contained in TSP and NaOH treated sample extracts. The reduction in TDS content is assumed to be a result of the precipitation of gypsum.

4.3.2.4 Kiln Dust Waste Rock Treatment

The addition of kiln dust at a rate of five percent by weight produced a treated sample pore water extract with a pH of 4.1. Analysis indicates the lowest concentrations of aluminum, barium, cadmium, copper, iron, manganese, nickel and zinc were produced by kiln dust addition. Substantial decreases in TDS and sulfate also occurred.

While the extract pH was 4.1, the kiln dust treated sample exhibited bicarbonate alkalinity at 392 mg/L. These data are conflicting and a possible cause is the evolution of carbon dioxide in the sealed container during shipment which could reduce pH. Once carbon dioxide is allowed to dissipate, pH would be anticipated to increase.

The indicated level of metal reduction following kiln dust addition is inferred to be caused by the carbonate content of the kiln dust. While NaOH and slaked lime reduce metal concentrations by the formation of hydroxide precipitates, kiln dust addition has the potential to reduce metal concentration by both carbonate and hydroxide formation.

4.3.3 Bulk Waste Rock Properties

The on-site test of bulk waste rock backfill porosity indicated 59 cubic feet of water were required to fill the void space in 360 cubic feet of backfill. The test indicates an available porosity of 19 percent and a pore volume in the 160,000 cubic yards of backfill of approximately 6.14 million gallons.

Monitoring of pH and TDS content indicated that the pore water in the backfill test pit reached equilibrium conditions in approximately 5 days with a pH of 1.97 and a TDS content of 86,000 mg/L. A sample of the backfill pore water following equilibration had an acidity concentration of 8,700 mg/L (as $CaCO_3$ at pH 8.0).

Assuming a backfill density of 120 pound per cubic foot, the test pit contained approximately 21.6 tons of backfill. At the time of the test, available acidity was contained in the backfill at a concentration of approximately 740 mg/kg.

5.0 HYDROGEOLOGIC EVALUATION

5.1 Hydrogeologic Conditions

The hydrogeology of the Barite Hill site is complex due to the highly fractured, faulted and heterogeneous nature of the rock. Due to these complexities, anisotropic conditions are likely to exist. Hydrogeologic investigations have been conducted in the rinsed agglomerate disposal area, however, limited data exists in the main pit area with respect to water level measurements, hydraulic conductivity, and boundary conditions. The post closure water level conditions were estimated on the basis of an analysis of water levels in three nearby monitoring wells.

During operations, Barite Hill estimates groundwater inflow rates to the pit were a maximum of approximately 20 gpm. Little or no inflow was observed until the pit was advanced below the 385 level. The current water level is approximately 402 feet and the pit has been estimated to contain approximately 57 million gallons.

5.2 Existing Conditions

Water levels for well GW-1 (northwest of the pit), GW-2 (northeast) and A-3 (south) average 385 ft, 398 ft and 438 ft msl, respectively, for the measurement period beginning in March 1991 and ending in March, 1995. The water table (or piezometric surface) south of the Main Pit appears to mimic surface topography indicating that shallow groundwater flow is to the south. The flow direction north of the pit can not be determined with available data, however, during high water table conditions, it is likely that groundwater will discharge into the northwest trending natural drainage located north and west of the open pit. Barite Hill reports that only intermittent flow has occurred in this drainage during mining operations as a result of surface water runoff following storm events.

At present, the pit appears to be refilling at a very slow rate. Water levels in wells proximal to the pit are probably being affected by pit inflow and are likely to rise when pit refilling is complete.

5.3 Groundwater Monitoring

Virtually all water level data collected from wells GW-1, GW-2 and A-3 were obtained during mining operations when the open pit acted as a sink. The data concerning pre-mining conditions, however, are within the range of fluctuation that occurred during mining. This suggests that post closure water levels around the open pit may not exhibit significant increases following pit closure. The variation of water levels in local monitoring wells is probably a result of local recharge and these fluctuations have been considered in estimating post closure water levels. Table 5.1 summarizes the range in observed water levels.

5.4 Estimation of Bulk Hydraulic Conductivity

The relative hydraulic conductivities of the backfill, backfill cover and pit wall rock will affect the groundwater surface gradients and water level in the post closure pit.

The bulk hydraulic conductivity of the rock in the vicinity of the pit was estimated by analogy to a pumping test, using estimated pit inflow rates and the local drawdown that occurred during pit dewatering. The thickness of the shallow bedrock aquifer was assumed to be 240 feet based on reports of a deep fracture zone at an elevation of 180 msl. For modeling purposes, pit dewatering was assumed to occur from a fully penetrating well located at the center of the open pit. The drawdown cone produced by dewatering was assumed to intersect the base of the pit walls (80 feet of drawdown). The steady state pumping rate was assumed to be 20 gpm based on data provided by Barite Hill personnel.

These data were employed in an iterative application of the Theis Equation to determine a hydraulic conductivity value that would result in the observed drawdown conditions and active mine dewatering (pumping) rates. The calculations suggest a bulk hydraulic conductivity of 0.09 ft per day (3.18×10^{-5} cm/sec), a value that is within the range of hydraulic conductivities measured in pump tests in the rinsed agglomerate disposal area (Rinsed Agglomerate Disposal Facility, Design and Solution Control, Final Design Report", ETE Inc. and Water Waste and Land Inc., March 1990). Hydraulic computations are contained in Appendix D.

The hydraulic conductivity conditions in the backfill will be impacted by the physical properties of the material and the method of backfill placement. The backfill will be placed in residual water contained in the open pit following volume reduction. The physical conditions (density, hydraulic conductivity, etc.) for placement can only be estimated at this time, however, the hydraulic conductivity of the backfill will exceed that of the rock in the vicinity of the open pit.

With placement of the low permeability clay cover material over the backfilled waste rock, the backfill groundwater flow could approach confined conditions. The clay cover material placed over the waste rock backfill (clay borrow fill used to contour the post closure pit surface) is anticipated to have an in-situ hydraulic conductivity of 5×10^{-5} to 5×10^{-6} cm/sec, a value that is similar to the estimated hydraulic conductivity of the intact pit area rock.

5.5 Estimation of Post Closure Water Levels

Figure 5.1 indicates the projected groundwater potentiometric surface level in the open pit following backfill and capping. The approximate configuration of the pit following backfill is also shown. The following assumptions and conditions were considered in estimating post closure water levels:

- The pit will be refilled with stockpiled backfill to an elevation of approximately 390 ft msl and capped with a low permeability cover.

- The cap will be graded to promote runoff to a drainage cut located on the north end of the pit. The cap will reduce recharge in the post closure pit to minimal levels. A groundwater mound in the pit backfill is not anticipated.

- Local recharge south of the open pit will produce a groundwater divide causing groundwater to flow north through the backfilled pit. The elevation of the divide can be approximated by the water level in Well A-3.

- When the pit fills, it will no longer act as a sink for groundwater. Steady-state post closure water levels are likely to be somewhat, but not significantly higher than current levels.

- The highest post closure groundwater levels could produce seeps in the natural drainage located north and northwest of the pit at an elevation of approximately 395 ft msl. The average maximum water level in the pit will be midway between 395 ft msl and the elevation of the groundwater divide.

- The lowest post closure groundwater level would not produce seeps in the natural drainage north of the pit. The average minimum water level in the post closure pit will be midway between the levels in Wells A-3, GW-1 and GW-2.

- Confined flow conditions will develop in the backfill.

Due to anticipated differences in the hydraulic conductivity of the waste rock backfill (10^{3} to 10^{-4} cm/sec) and the intact wall rock and clay cover (10^{5} to 10^{-6} cm/sec), the hydraulic gradient in the pit area could be relatively flat. If fully confined conditions develop in the pit backfill the potentiometric surface in the vicinity of the post closure drainage cut can be estimated. The depth of fill is significant with respect to avoiding the development of seeps or quick conditions in this location.

The minimum post closure pit water level (potentiometric level in the center of the pit) is estimated to be above 400 feet. This level was calculated by averaging the water levels of the monitor wells and subtracting three standard deviations.

The maximum post closure pit water level is estimated to be higher than 425 ft msl. This level was calculated by adding two standard deviations to the mean water level at A-3 and averaging this level with 395 ft msl, the level of potential seeps in the natural drainage located north and west of the pit.

These estimates apply to the center of the open pit after steady state conditions are achieved. In the area proposed for the surface water drainage cut, estimated groundwater levels for low and high water table conditions range from approximately 395 to 410 ft msl.

Based on the analyses presented above, the pit will fill to a level above the sulfide waste backfill. With the placement of the post closure drainage cut at an elevation of 405 feet msl, the cut would be above the anticipated groundwater level (near 400 feet msl) for average conditions. The potential for the development of a seep in the surface drainage cut or central drainage areas exist. Placement of additional fill material and plugging the lower portion of the drainage cut could be undertaken as a contingency measure should seeps develop.

5.6 Groundwater Quality

Table 5.2 contains a summary of the high, low and average concentration of constituents in groundwater that are contained in significant concentration in the pit water. It should be noted that during the period of monitoring (3/91 to 3/95), the main pit water level was affected by dewatering and local drawdown of the groundwater. The local groundwater flow during the period of monitoring was toward the open pit.

Anomalous values for iron, aluminum and copper were measured in monitor well GW-1 in the initial sampling events in 1991. In Table 5.2, the high values, which were assumed to be a result of incomplete well development, were discounted.

The primary constituents of the local groundwater are iron, aluminum, copper, manganese and zinc. In general, the concentration of metals and their variation in concentration is reduced in upgradient well A-3. The maximum concentrations of aluminum (84 mg/L), iron (238 mg/L) and copper (1.37 mg/L) were detected in monitoring well GW-1. The maximum concentration of zinc (3.83 mg/L) was detected in monitor well GW-2. The maximum concentration of manganese was 3.0 mg/L in well A-3.

Visual inspection of exposed pit walls indicates sulfide mineralization locally extends above the premine groundwater level to the near surface. Higher metal concentrations in down gradient wells GW-1 and GW-2 are considered to be indicative of in situ oxidation of the sulfides contained in the rocks in and adjacent to the open pit that has occurred over geologic time.

6.0 RECLAMATION AND CLOSURE ACTIVITIES

6.1 Pit Water Pretreatment

Prior to and during volume reduction activities, pretreatment of the pit water will occur in order to elevate pH, limit metal solubility and inhibit continued oxidation. The presence of ferric iron will also result in the oxidation of sulfides. Maintenance of a pH level to control ferric iron will be performed to alleviate the rate of ongoing oxidation.

6.2 Pit Water Treatment

Based on the amendment material evaluation previously conducted, slaked lime (CaOH) has been selected as the preferred alternative base material for treatment of the pit water. Both the reactivity and cost of this product make is a suitable candidate for use in elevating the pit water pH, suppressing ferric iron and reducing sulfate concentrations through the introduction of calcium and subsequent precipitation of gypsum.

Introduction of the slaked lime will involve the excavation of a sump within the pit below the pit water level. The sump will initially be constructed on the west haul road of the Main Pit near the current pit water level as shown on Figure 6.1. This will allow access to the sump while maintaining a steady inflow of pit water into the sump by gravity flow.

The slaked lime will be placed into the sump on an as needed basis, and mixed with the pit water. A hydraulic monitor or spray jet will be used to slurry the mixture. The pit water and slurried lime mixture will be recycled into the pit. As the pit water level decreases, the sump will be reconstructed at a lower elevation in order to maintain inflow of pit water.

A 6-inch, stainless steel, self priming centrifuge pump will be used to pump the pit water and lime slurry mixture to the pit through a 6-inch HDPE pipe. The mixture will discharged in a stream/mist form back over the pit walls and water surface. Spray nozzles will be fitted to the slurry/pit water discharge line. This process will serve to both add slaked lime to the pit water and reduce the pit water volume through evaporation as is discussed below.

Liquid NaOH may be substituted for the slaked lime. Liquid NaOH would be introduced directly from tankers to a pumped pit water stream and mixed with a venturi. The spray evaporation system would be used for returning the NaOH and water to the pit. The NaOH mixing system would be closed, thereby minimizing health and safety risks associated with the use of caustic would be minimized.

6.3 Pit Water Volume Reduction

The pit water volume reduction will be accomplished by spray evaporation within the existing boundaries of the Main Pit. In the event that spray evaporation fails to reduce the pit water volume to an appropriate level for completion of backfilling operations, a portable water treatment system may be employed as a contingency measure to treat the pit water to surface discharge standards.

The current pit water volume is estimated to be approximately 57 million gallons. Based on the results of on-site bulk porosity testing, the available water storage capacity of the stockpiled backfill is approximately 19 percent or 6.14 million gallons. Reduction of the pit water volume to a volume equivalent to the waste rock backfill void space will leave the backfill saturated following placement and the surface of the backfill free of excess water in preparation for placement of the reclamation cover. A reduction of approximately 50.9 million gallons will be required.

The spray application of pit water to exposed pit walls could increase solution loss rates. Exposed surface areas in the open pit cover in excess of 8.5 acres of which approximately 5 acres would be exposed to direct sunlight throughout the year. Assuming a 1000 gpm system and a medium spray, the solution losses from pit wall spraying could range from 4 to 10 percent in winter and summer months, respectively (1.7 to 4.3 million gallons per month).

Operation of the spray evaporation system is anticipated to require approximately 17 months to reduce the current pit water volume to that required to fill the void spaces in the backfill material.

The formation of precipitates, primarily gypsum ($CaSO_4$), in the pipe and nozzle system is anticipated during volume reduction. The system will therefore be constructed in a manner such as to allow for ready access and periodic maintenance/cleaning of the nozzles.

6.4 Oxidation Control During Volume Reduction

Ferric iron will precipitate as ferric hydroxide in pH conditions above approximately 3.5. To reduce the potential for ongoing oxidation during the pit water volume reduction, pretreatment of the pit water to a minimum pH of 4.0 will be employed with final treatment completed following volume reduction.

6.5 Sulfate Reduction

The pit water contains approximately 2,400 mg/L sulfate. During volume reduction, the salt content of the pit water can be anticipated to increase. Excess salt in the pit water will adversely impact pipes and spray nozzles through the formation of precipitates, and could potentially impact rates of evaporation.

Addition of calcium from sources such as slaked lime will be used to reduce sulfate content by gypsum precipitation.

6.6 Final Pit Water Treatment

Following pit water volume reduction, final treatment of the residual pit water to produce acceptable water quality will be undertaken through the addition of base materials. By maintaining the pH near 4.0 during volume reduction, the additional slaked lime and/or NaOH requirements will be limited, as the majority of the acidity in the pit water will have been effectively neutralized.

6.7 Waste Rock Backfill Amendment

The preferred material for neutralization of the waste rock also appears to be slaked lime. Slaked lime is effective in neutralizing acidity and reducing concentrations of dissolved metals.

Addition rates of slaked lime are presented in Sections 4.2 and 4.3. Based on data from field acidity testing conducted in 1995 and an assumed density of 120 pounds per cubic foot, approximately 7,280 tons (2.8 percent by weight) of slaked lime would be required to neutralize acidity contained in the waste rock backfill.

With ongoing oxidation of the backfill prior to its placement in the pit, the leachable quantity of acidity may increase. Immediately prior to commencement of backfilling, additional testing of available acidity will be undertaken to refine base material quantity estimates.

To estimate backfill base addition rates, the following test procedure will be used.

- Four samples of the waste rock backfill will be obtained from test pits excavated at widely distributed locations in the waste rock stockpile areas;

- Sample weight will be approximately 50 pounds;

- Each sample will be submerged in deionized water, agitated for a period of 5 minutes and allowed to stand;

- The pH and conductivity and TDS content of the pore water in each test will be monitored until a stable condition is achieved.

- Upon achievement of a stable conditions, a portion of the pore water will be decanted, filtered and submitted for analysis of acidity.

The on-site leaching test indicated an equilibrium acidity of 8700 mg/L for which a 2.8 percent slaked lime addition rate was estimated in bench scale backfill neutralization tests. If the leach tests described above indicate an increase in leachable acidity, some increase in lime addition rates may also be warranted. Base addition rates in the range of 2.8 to 4.0 percent by weight are anticipated.

Slaked lime will be spread on the surface of the waste rock backfill material in the stockpile areas and blended with the backfill when the material is pushed by dozer into the pit. Surface application rates for slaked lime will be determined on the basis of amount of backfill that can practically pushed into the pit at any given time. For example, if a three foot layer of waste rock backfill can be moved with each pass of the dozer, the weight of backfill moved (at an assumed density of 120 pounds per cubic foot) will be approximately 0.18 tons/square foot. For the anticipated surface application rate resulting in a 2.8 percent by weight amendment rate, slaked lime would be spread over the backfill at a rate of 10 pounds per square foot.

6.8 Pit Backfill and Cover Placement

Placement of stockpiled waste rock backfilling will raise the pit floor to an elevation of approximately 390 feet msl. An additional 368,000 cubic yards of material will be required to bring the final pit bottom elevation, including the clay cap, to an elevation of 5 feet above the estimated post closure groundwater level (Figure 5.1).

Waste rock backfill will be placed into pit water remaining following volume reduction. The above water backfill and cover material will be obtained by cutting the pit walls at a 3H:1V slope and from the clay borrow area. Cut and fill zones are shown in cross section on Figure 6.2. Approximately 210,000 bank cubic yards of pit wall rock and clay materials will be obtained from slope reduction activities. Wall rock will be used as additional backfill while saprolitic clays will be used for backfill and/or low permeability cover material. Up to an additional 194,000 cubic yards of material will be obtained from the clay borrow area within the Main Pit to complete backfilling and cover placement, burial of pit walls and regrading. Figure 6.3 illustrates a typical section through the pit cover system.

Backfill placed above the residual pit water level and beneath the final cover will be spread in lifts with a maximum thickness of 5 feet and compacted with equipment traffic. The upper 24 inches of the low permeability soil cover will be spread in 6-inch maximum loose lifts and compacted to a 5 percent of maximum dry density (ASTM D698) at plus or minus 5 percent of optimum moisture content. The upper cover will have a maximum hydraulic conductivity of 5 x 10^6 cm/sec. Prior to placement of the final cover, the fill materials in the final cover foundation area will be scarified and compacted. Technical specifications for cover construction, and a quality assurance program for cover placement are contained in Appendices E and F.

6.9 Pit Drainage Cut

The pit drainage cut will be constructed at an elevation of 405 feet msl at the northern end of the pit. The drainage cut will be constructed with 3H:1V sides slopes and a channel slope of 0.25 percent. The cut will be capped with low permeability soil material and revegetated. Soil cover will be employed to alleviate the potential for exposure of oxidizable rock in the drainage cut.

Runoff from the regraded and revegetated pit that could occur as a result of the 100-year, 24-hour storm (8.0 inches) was estimated with the computer program WASHED (Appendix D). The pit was modelled as 100 percent grass covered with a soil cover having an SCS runoff of coefficient of 80 for antecedent moisture condition (AMC) II. The spillway outlet was modelled as a 10 foot wide drainage ditch with 3H:1V side slopes and a channel grade of 0.25 percent. A Manning's N value of 0.035 was assumed for a grass covered channel. Hydrologic data is contained in Appendix D.

Based on the WASHED simulation, the maximum runoff rate for the 100-year storm event was estimated to be 71 cfs. For the channel conditions described above, the discharge velocity through the drainage cut was estimated to be 2.53 feet per second. Under these conditions, grass cover is indicated to be suitable for providing long-term erosion protection. Erosion control netting or similar materials may be used for temporary erosion protection in the drainage cut. A section through the drainage cut is shown on Figure 6.4.

7.0 MONITORING

7.1 Operational Monitoring

During backfill operations, pit water pretreatment and backfill amendment will be carried out to maintain alkaline conditions, reduce metal solubility and alleviate the potential for ongoing oxidation. A primary concern is ferric iron. Maintenance of a minimum pH of 4.0 will result in the precipitation of ferric iron as ferric hydroxide.

During pit water volume reduction and backfill operations, Barite Hill will monitor pit water for selected water quality parameters on a weekly basis. Weekly monitoring parameters include alkalinity/acidity, pH, total dissolved solids (TDS) content and conductivity. Monitoring of these parameters will be used as a guide to determine if interim treatment of water is required, of to evaluate the effectiveness of waste rock amendment rates.

On a monthly basis, comprehensive monitoring of pit water quality will be conducted. In addition to the weekly parameters, the monthly parameter list will include the following analytes:

Alkalinity as $CaCO_3$
Bicarbonate as $CaCO_3$
Hydroxide as $CaCO_3$
Conductivity
pH
Hardness as $CaCO_3$
Chloride
Sulfate
Nitrogen, ammonia
Nitrate as N, dissolved
Nitrite as N, dissolved

Metals (dissolved)
Al, As, Ca, Cd, Cu, Fe, Pb,
Mn, Mg, Hg, Na, Ni, Se, Ag, and Zn

7.2 Post Closure Monitoring

Groundwater monitoring in existing monitoring wells will be conducted on a quarterly basis through post-closure period to assess the effectiveness of the closure procedures. Groundwater samples will be analyzed for currently specified parameters for groundwater quality monitoring at existing monitoring wells.

The quality of surface runoff from the reclaimed pit will be periodically monitored following storm events of sufficient intensity to result in runoff, with the number of sampling events not to exceed four times per year. A surface water monitoring point will be established at the outlet of the drainage cut in the existing natural drainage north of the Main Pit. Surface water runoff will be analyzed for the parameters listed in Section 7.1.

Surface water and groundwater quality monitoring will be carried out until such time as it is determined, in consultation with the South Carolina Department of Health and Environmental Control (DHEC), that monitoring is no longer required.

7.3 Cover Performance Monitoring

The pit cover system will be inspected on an annual basis until such time as self-sustaining vegetation capable of controlling surface erosion is established. Areas subject to erosion will be repaired with placement of additional low permeability soil and growth media as required. Periodic applications of seed and soil amendments may be required to facilitate establishment of self sustaining vegetation. Cover system inspections will be conducted until such time at it is determined, in consultation with DHEC, that inspections are no longer required.

8.0 CONTINGENCY MEASURES

8.1 Pit Water Volume Reduction

In the event that the spray evaporation system is unable to reduce the pit water volume to 6.14 million gallons (the estimated volume required to fill the available pore space in the backfill), a portable water treatment system may be employed. The pit water would be treated to meet existing NPDES discharge standards.

8.2 Groundwater Quality

The existing water quality in wells adjacent to the pit exhibit water quality reflects oxidation of sulfides in local country rock that has probably occurred and will occur over geologic time. Moderate concentrations of aluminum, iron, copper, manganese and zinc have been detected in Main Pit area wells during the mining operation (Table 5.2) Because the pit acted as a sink during operations while dewatering was undertaken, metal concentrations measured in local monitoring wells are not likely a result of the mining operation.

Following completion of backfilling operations, it is anticipated that oxidation of the backfill will be controlled as a result of base addition, subaqueous disposal and low permeability cover placement. Impacts to water quality in the vicinity of the Main Pit are not anticipated, however, should unsatisfactory ground water quality conditions develop, groundwater interception and treatment could be undertaken. An interception system would involve utilizing the existing groundwater wells, GW-1 and GW-2, or new strategically placed wells should the need arise. Groundwater recovery rates are anticipated to be low (less that 25 gpm) and it is likely that a passive treatment system could be employed to manage this water.

8.3 Surface Water Quality

The pit cover system will be placed over the entire disturbance area of the Main Pit. As such, rocks capable of oxidation and metal leaching will be isolated from contact with surface runoff. Under these conditions, impacts to surface water quality from the closed and reclaimed pit are not expected.

In the event that surface water runoff quality monitoring indicates metal leaching from pit wall rocks or exhibits quality suggesting the presence of oxidation products from pit backfill, the cover system will be inspected and repaired as necessary to alleviate impacts to surface water. Contingency measures include placing additional low permeability soil and/or growth media to minimize contact of surface water with potential sources of leachable metals.

8.4 Springs and Seeps

The ultimate post closure pit water level has been conservatively estimated on the basis of available water level data from local groundwater monitoring wells. The cover system has been designed to provide a minimum of 5 feet of fill over the anticipated equilibrium groundwater surface level. The purpose of placing cover fill in this manner is to minimize the potential for the development of springs or seeps in the cover system.

In the event that the equilibrium post closure groundwater level exceeds anticipated levels, additional low permeability soil from the clay borrow area will be placed in the pit to raise the backfill above the equilibrium groundwater level. This may also require raising the elevation of the post closure drainage cut. In the event that these measures are required, plans and specifications for pit modifications will be submitted to DHEC for review and approval.

Tables

TABLE 3.1
SUMMARY OF SELECTED CONSTITUENTS IN RECENT PIT WATER SAMPLES
Barite Hill Project
McCormick, South Carolina

Analyte	3/15/95 Sample	6/30/95 Sample
pH	5.9	7.2
Cond (μS)	4300	4420
Ag	*ND*	*ND*
Al	0.589	14.6
Ba	*ND*	0.043
Ca	58.2	66.7
Cd	0.9347	1.151
Cr	*ND*	*ND*
Cu	51	24.9
Fe	0.727	57.5
K	11.3	10.4
Mg	15.2	18.8
Mn	4.58	5.67
Na	631	572
Ni	0.292	0.33
Zn	11.8	15.5
Hg	0.00173	*ND*
As	*ND*	*ND*
Pb	*ND*	0.035
Se	1.34	1.346
Alkalinity (mg/L)	16.2	*ND*
Cl^- (mg/L)	359	208
Sulfate (mg/L)	1990	2390
TDS (mg/L)	2550	3070

Note: All metals are total concentration in mg/L.

ND = nondetect

TABLE 4.1
PIT WATER TREATMENT TESTS
Barite Hill Project
McCormick, South Carolina

Treatment	*TSP*	*NaOH*	*CaOH*	*Kiln Dust*
Analyses				
Al	*ND*	0.08	*ND*	*ND*
As	0.002	*ND*	*ND*	*ND*
Ba	*ND*	0.01	0.009	0.041
Cd	0.216	0.213	*ND*	0.65
Ca	54.6	77.2	279	262
Cu	0.42	3.55	1.32	2.53
Fe	0.17	0.48	0.09	5.09
Pb	*ND*	*ND*	*ND*	*ND*
Mn	3.88	5.22	0.04	5.41
Ni	0.26	0.07	0.11	0.28
Se	1.03	1.07	0.71	1.06
Ag	*ND*	*ND*	*ND*	*ND*
Zn	3.63	0.41	0.14	10.2
Acidity	75	*ND*	*ND*	40
Alkalinity				
Bicarb	15	30	*ND*	15
Carb	*ND*	20	40	*ND*
Hydrox	*ND*	*ND*	101	*ND*
otal Alkalinity	15	50	141	15
pH	6	8.6	11.1	6.5
Phosphorous	17.3	*NT*	*NT*	*NT*
TDS	2770	2980	2800	3260
Sulfate	2100	2000	1700	2500

ND = nondetect
NT = not tested

TABLE 4.2
NEUTRALIZATION TESTS
Barite Hill Project
McCormick, South Carolina

Treatment	*TSP*	*NaOH*	*CaOH*	*Kiln Dust*
Analyses				
Al	10.3	13.6	26.1	5.52
As	0.02	0.02	0.5	0.38
Ba	0.896	1.19	1.7	1.54
Cd	0.017	0.041	0.076	*ND*
Ca	103	252	489	576
Cu	0.49	1.66	3.38	0.38
Fe	23.2	44.4	99.7	19.8
Pb	0.25	0.25	0.46	0.28
Mn	3.24	6.24	5.75	1.3
Ni	0.59	0.14	0.28	0.03
Se	0.36	0.49	0.18	0.27
Ag	0.012	0.031	0.016	0.022
Zn	8.51	16	22.6	1.75
Acidity	80	80	195	*ND*
Alkalinity				
Bicarb	236	15	*ND*	392
Carb	*ND*	*ND*	*ND*	*ND*
Hydrox	*ND*	*ND*	*ND*	*ND*
otal Alkalinity	236	15	*ND*	392
Conductivity	48000	57000	5980	8240
pH	7.6	6.3	5.5	4.1
TDS	52300	67200	6560	8360
Sulfate	35300	45900	3900	3500

ND = non-detect

TABLE 5.1
OBSERVED FLUCTUATIONS IN LOCAL WATER LEVELS
FOR THE FOUR-YEAR MONITORING PERIOD ENDING IN MARCH, 1995

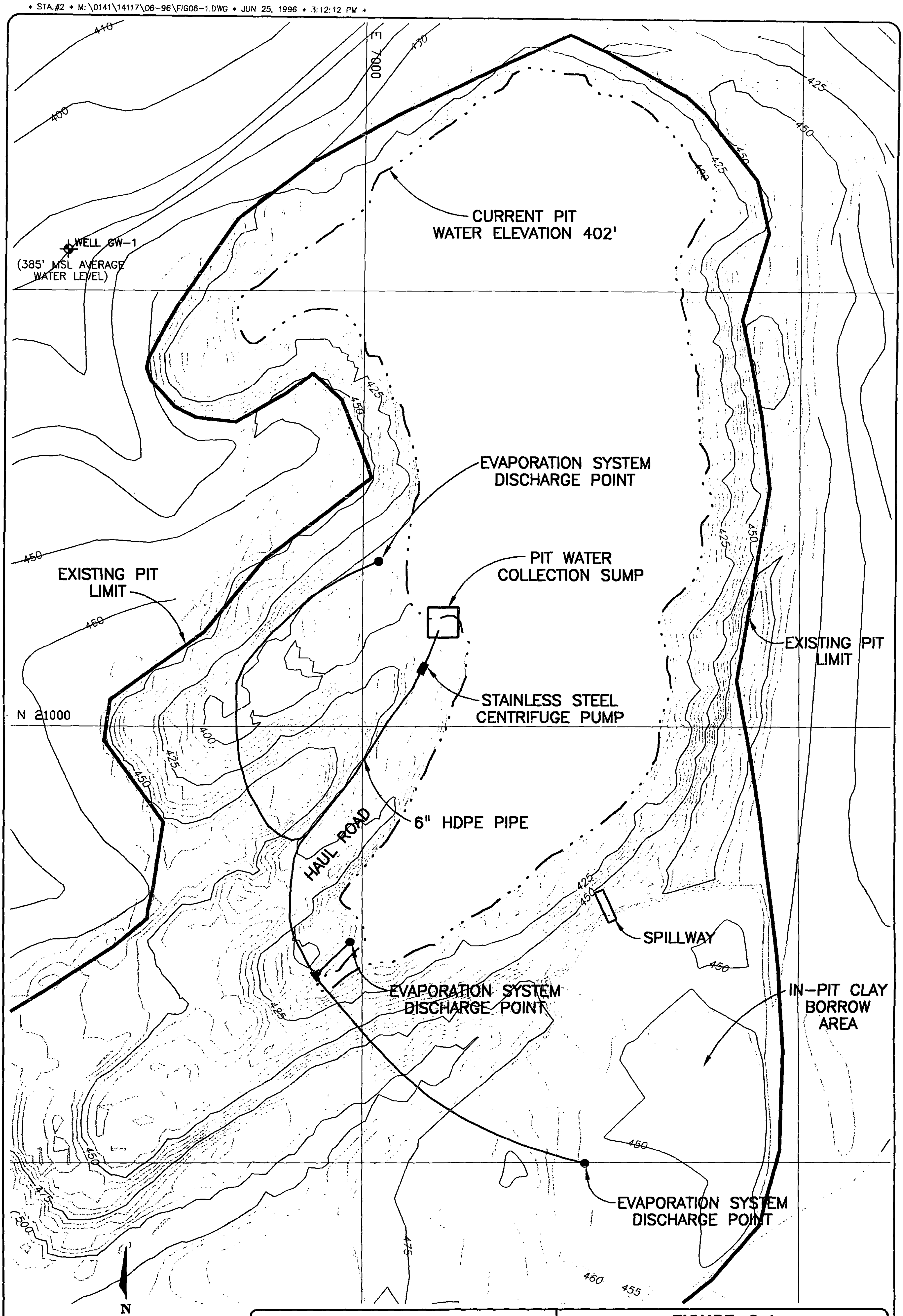
Well	Minimum (ft msl)	Maximum (ft msl)	Mean (ft msl)	Standard Deviation (ft)
A3	433.5	443.0	437.9	3.022
GW-1	381.2	389.1	384.9	1.775
GW-2	390.9	404.2	398.0	2.840

TABLE 5.2
SUMMARY OF MAIN PIT AREA MONITOR WELL DATA
Barite Hill Project
McCormick, South Carolina

	WELL GW-1				WELL GW-2				WELL A-3			
CONSTITUENT (MG/L)	MAX	MIN	AVG	ST. DEV	MAX	MIN	AVG	ST. DEV	MAX	MIN	AVG	ST. DEV
Al	84.00	2.24	25.86	26.02	29.90	2.05	11.61	9.21	71.00	0.24	11.56	21.84
As	0.01	0.00	0.00	0.00	0.04	0.00	0.01	0.01	0.01	0.00	0.00	0.00
Ba	0.92	0.09	0.33	0.25	0.78	0.08	0.30	0.22	0.53	0.10	0.18	0.11
Cd	0.04	0.00	0.01	0.01	0.12	0.00	0.04	0.04	0.01	0.00	0.00	0.00
Ca	17.00	1.60	4.46	3.71	22.70	1.43	14.00	8.03	4.00	0.00	0.78	1.39
Cu	1.37	0.05	0.38	0.38	1.07	0.07	0.41	0.31	1.00	0.02	0.16	0.26
Fe	238.00	4.70	70.02	72.63	94.60	12.10	41.36	25.33	128.00	0.43	23.20	39.02
Pb	0.06	0.00	0.03	0.02	0.46	0.03	0.12	0.12	0.08	0.00	0.01	0.02
Mn	1.57	0.10	0.58	0.49	0.70	0.08	0.33	0.18	3.00	0.01	0.50	1.02
Ni	0.04	0.01	0.02	0.01	0.18	0.01	0.05	0.05	0.15	0.01	0.04	0.04
Se	0.01	0.00	0.00	0.00	0.03	0.00	0.01	0.01	0.02	0.00	0.00	0.00
Ag	0.02	0.01	0.01	0.00	0.07	0.01	0.01	0.02	0.01	0.01	0.01	0.00
Zn	1.72	0.04	0.25	0.41	3.83	0.11	1.47	1.16	0.38	0.01	0.09	0.12

C:\PROJECTS\BARITE HILL\Table 5.2, WELLDATA

FIGURES

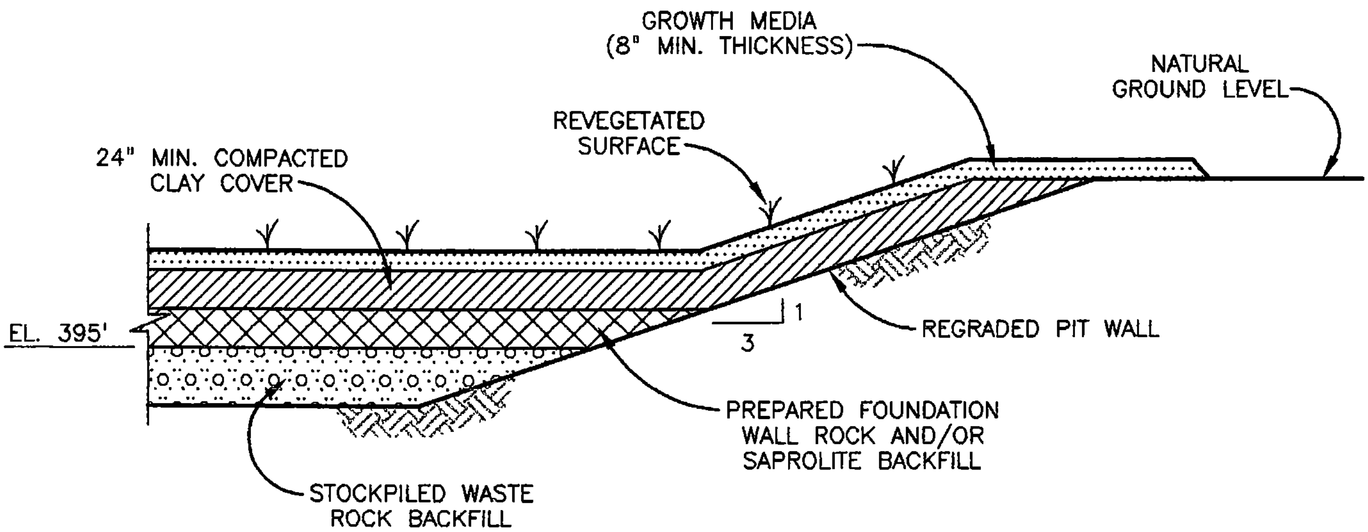


SRK
STEFFEN ROBERTSON & KIRSTEN (U.S.)
Consulting Engineers & Scientists

PROJECT NO.	DATE	REVISION
14117	06/96	A

FIGURE 6.1

PRETREATMENT AND EVAPORATION SYSTEM
Barite Hill Project



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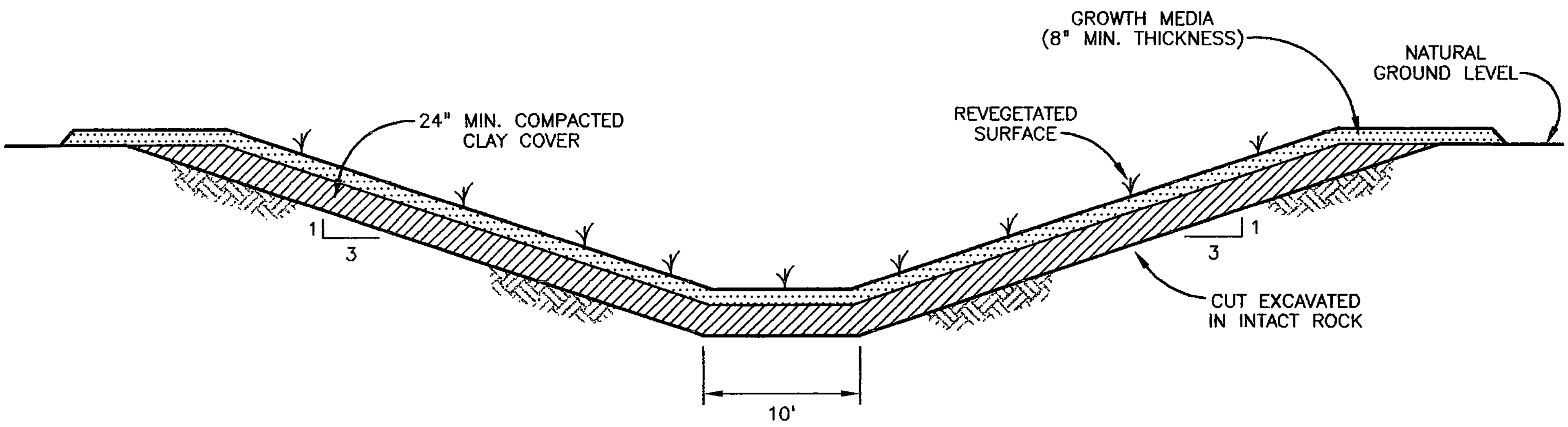
Consulting Engineers & Scientists

PROJECT NO.	DATE	REVISION
14117	06/96	A

FIGURE 6.3

TYPICAL SECTION
PIT COVER SYSTEM

* STA.#2 * M:\0141\14117\06-96\FIG06-3.DWG * JUN 25, 1996 * 3:16:29 PM *



NOTES:

1. CUT INLET ELEVATION AT 405 FEET MSL.

2. DRAINAGE CUT BED SLOPE TO BE 0.25% MAXIMUM.

STEFFEN ROBERTSON & KIRSTEN (U.S.)
Consulting Engineers & Scientists

PROJECT NO.	DATE	REVISION
14117	06/96	A

FIGURE 6.4

POST CLOSURE DRAINAGE CUT

ENGINEER	No.	DESCRIPTION	BY	DATE
	A	ISSUED FOR CLIENT REVIEW	GM	6/96

REVISIONS

PREPARED FOR:
NEVADA GOLDFIELDS, INC.
Barite Hill Project

PREPARED BY:
SRK
STEFFEN ROBERTSON & KIRSTEN (U.S.)
Consulting Engineers & Scientists

TITLE:
GENERAL FACILITIES ARRANGEMENT

SCALE: AS SHOWN

DRAWING No.:
FIGURE 1.1

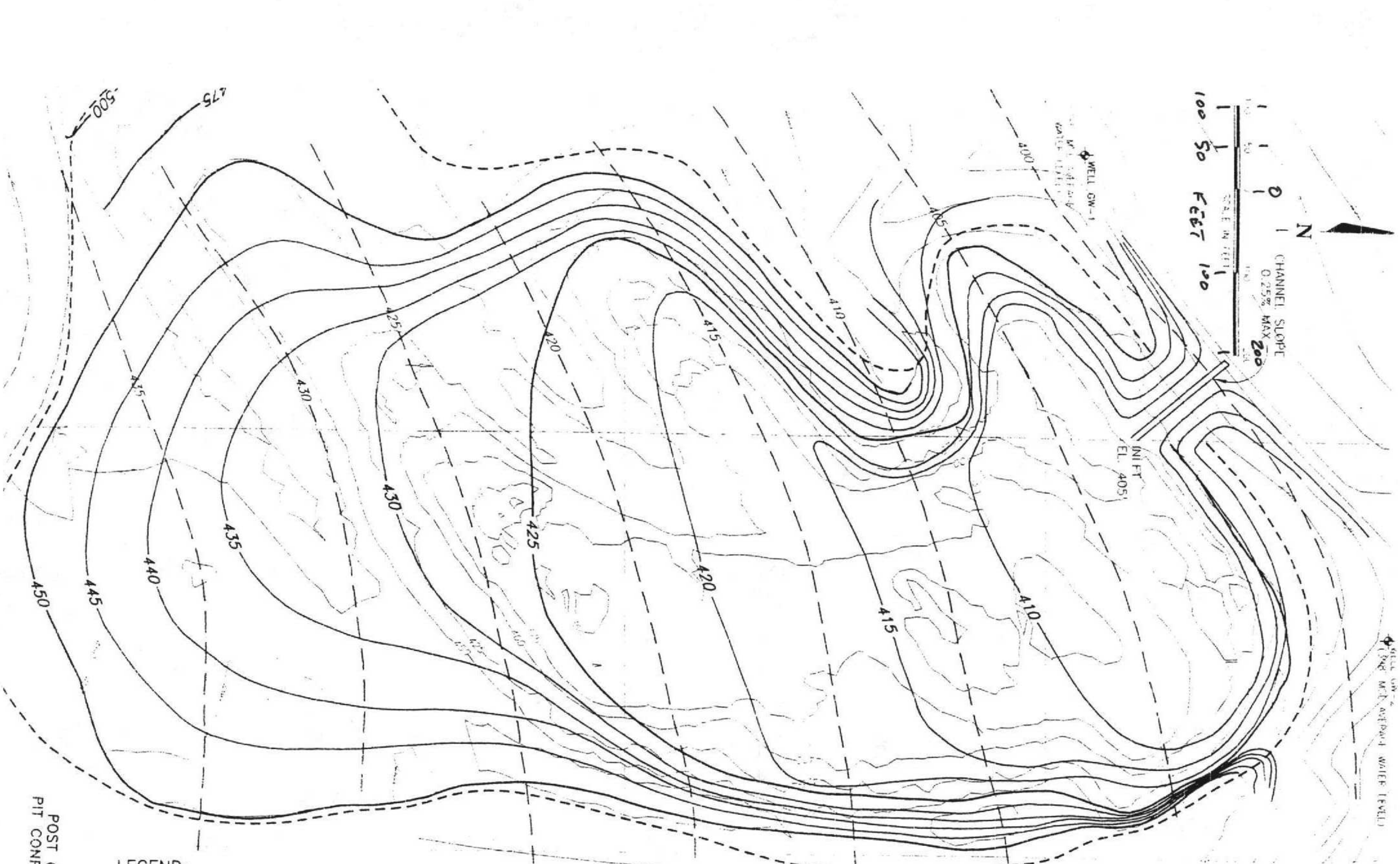
PROJECT No.: 14117

REVISION A

REFERENCE

DESIGNED	MW	06/96
DRAWN	PMW	06/96
CHECKED	MW	06/96
APPROVED	GM	06/96
APPROVED		

Mining



POST CLOSURE
PIT CONFIGURATION

LEGEND:

APPROXIMATE POST CLOSURE CONTOUR

ESTIMATED POST CLOSURE POTENTIOMETRIC SURFACE CONTOUR (INTERMEDIATE OR AVERAGE CONDITION)

APPROXIMATE EXTENT OF SOIL COVER

PREPARED FOR: NEVADA GOLDFIELDS, INC. Barite Hill Project

PREPARED BY: SRK STEFFEN ROBERTSON & KIRSTEN (U.S.) Consulting Engineers & Scientists

TITLE: POST CLOSURE PIT CONFIGURATION

SCALE: AS SHOWN

DRAWING No.: FIGURE 5.1

PROJECT No.: 14117

REVISION: A

ENGINEER	No.	DESCRIPTION	BY	DATE
	A	ISSUED FOR CLIENT REVIEW	GM	6/96

REVISIONS

REFERENCE

DESIGNED	MW	06/96
DRAWN	PMW	06/96
CHECKED	MW	06/96
APPROVED	GM	06/96
APPROVED		

MINING

PREPARED FOR: NEVADA GOLDFIELDS, INC. Barite Hill Project	PREPARED BY: SRK STEFFEN ROBERTSON & KIRSTEN (U.S.) Consulting Engineers & Scientists
TITLE: PIT BACKFILL AND GRADING SECTIONS	SCALE: AS SHOWN DRAWING No.: FIGURE 6.2 PROJECT No.: 14117 REVISION A

DESIGNED	MW	06/96
DRAWN	PMW	06/96
CHECKED	MW	06/96
APPROVED	GM	06/96
APPROVED		

REVISIONS

No.	DESCRIPTION	BY	DATE
A	ISSUED FOR CLIENT REVIEW	GM	6/96

mining

Appendices

APPENDIX A
PIT WATER QUALITY DATA

Davis & Floyd, Inc.

Laboratory Analysis Report

Work Order # 95-03-165

Received: 03/15/95

03/30/95 09:36:56

Test Description	Units	01 MAIN PIT	02 MAIN PIT DUP
GROUNDWATER ELEVATION	Feet Above MSL	NA	NA
pH (FIELD ANALYSIS)	pH units	5.9	5.9
SPECIFIC CONDUCTANCE (FLD)	micromhos/cm	4300	4300
TEMPERATURE	Degrees C	16	16
SILVER (TOTAL)	mg/l	< 0.010	< 0.010
ALUMINUM (TOTAL)	mg/l	0.589	0.609
BARIUM (TOTAL)	mg/l	< 0.020	< 0.020
CALCIUM (TOTAL)	mg/l	58.2	58.7
CADMIUM (TOTAL)	mg/l	0.9347	0.9369
CHROMIUM (TOTAL)	mg/l	< 0.010	< 0.010
COPPER (TOTAL)	mg/l	51.0	51.4
COPPER (DISSOLVED)	mg/l	48.9	48.9
IRON (TOTAL)	mg/l	0.727	0.783
POTASSIUM (TOTAL)	mg/l	11.3	11.3
MAGNESIUM (TOTAL)	mg/l	15.2	15.3
MANGANESE (TOTAL)	mg/l	4.58	4.58
SODIUM (TOTAL)	mg/l	631.	639.
NICKEL (TOTAL)	mg/l	0.292	0.291
ZINC (TOTAL)	mg/l	11.8	11.9
MERCURY (TOTAL)	mg/l	0.00173	0.00173
ARSENIC (TOTAL)	mg/l	< 0.0050	< 0.0050
LEAD (TOTAL)	mg/l	< 0.020 X	< 0.020 X
SELENIUM (TOTAL)	mg/l	1.34	1.33
ORGANIC CARBON TOTAL	mg/l	64.1	66.7
ALKALINITY BICARBONATE	mg/l	16.2	11.7

Davis & Floyd, Inc.

Laboratory Analysis Report

Received: 03/15/95

03/30/95 09:36:56

Work Order # 95-03-165

Continued From Above

Test Description	Units	01 MAIN PIT	02 MAIN PIT DUP
CHLORIDE	mg/l	359	357
SULFATE	mg/l	1990	1870
AMMONIA NITROGEN	mg/l	90.8	92.8
NITRITE NITROGEN	mg/l	0.336	0.314
NITRATE NITROGEN	mg/l	11.0	10.7
CYANIDE (TOTAL)	mg/l	38.0	39.8
DISSOLVED SOLIDS TOTAL	mg/l	2550	2580

Received: 03/15/95

03/30/95 09:36:56

NEVADA GOLDFIELDS, INC.

NOTES:

X = INDICATES A MATRIX INTERFERENCE WHICH MAY REQUIRE A DILUTION OR WHICH PREVENTS THE REPORTING OF A RESULT. DETECTION LIMITS HAVE BEEN ADJUSTED WHERE APPLICABLE.

Davis & Floyd, Inc.

Laboratory Analysis Report

Work Order # 95-03-165

Received: 03/15/95

03/30/95 09:36:56

REPORT TO NEVADA GOLDFIELDS, INC.
P.O. BOX 1530
McCORMICK, SC 29835

PREPARED BY DAVIS & FLOYD, INC.
P.O. DRAWER 428
GREENWOOD, SC 29648

CERTIFIED BY

JOHN_MCCORD

ATTEN JEAN WHISNANT

PHONE (803)-229-5211

WORK ID JOB NO. 7561.00
P.O. # N/A
TAKEN DAVIS & FLOYD, INC
TYPE SURFACE H2O
NUMBER OF SAMPLES 2

Comments:
WE ARE PLEASED TO PROVIDE THIS CERTIFIED REPORT OF ANALYSES.
FEEL FREE TO TELEPHONE IF FURTHER EXPLANATION IS REQUIRED.
UNLESS OTHER ARRANGEMENTS HAVE BEEN MADE, SAMPLES WILL BE
DISPOSED OF OR RETURNED 14 DAYS FROM THE DATE OF THIS REPORT

SAMPLE IDENTIFICATION	DATE COLLECTED
01 MAIN PIT	03/14/95 11:05:00
02 MAIN PIT DUP	03/14/95 11:05:00

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 2
Received: 06/30/95

Work Order # 95-06-312

07/14/95 10:55:28

Test Description	Units	01 MAIN PIT
GROUNDWATER ELEVATION	Feet Above MSL	NA
pH (FIELD ANALYSIS)	pH units	7.2
SPECIFIC CONDUCTANCE (FLD)	micromhos/cm	4420
TEMPERATURE	Degrees C	25
SILVER (TOTAL)	mg/l	< 0.010
ALUMINUM (TOTAL)	mg/l	14.6
BARIUM (TOTAL)	mg/l	0.043
CALCIUM (TOTAL)	mg/l	66.7
CADMIUM (TOTAL)	mg/l	1.151
CHROMIUM (TOTAL)	mg/l	< 0.010
COPPER (TOTAL)	mg/l	24.9
COPPER (DISSOLVED)	mg/l	24.7
IRON (TOTAL)	mg/l	57.5
POTASSIUM (TOTAL)	mg/l	10.4
MAGNESIUM (TOTAL)	mg/l	18.8
MANGANESE (TOTAL)	mg/l	5.67
SODIUM (TOTAL)	mg/l	572
NICKEL (TOTAL)	mg/l	0.330
ZINC (TOTAL)	mg/l	15.5
MERCURY (TOTAL)	mg/l	< 0.00020
ARSENIC (TOTAL)	mg/l	< 0.0200X
LEAD (TOTAL)	mg/l	0.0350
SELENIUM (TOTAL)	mg/l	1.346
ORGANIC CARBON TOTAL	mg/l	38.8
ALKALINITY BICARBONATE	mg/l	< 1.0

Davis & Floyd, Inc.

Laboratory Analysis Report

Page 3
Received: 06/30/95

07/14/95 10:55:28

Work Order # 95-06-312
Continued From Above

Test Description	Units	01 MAIN PIT
CHLORIDE	mg/l	208
SULFATE	mg/l	2390
AMMONIA NITROGEN	mg/l	94.5
NITRITE NITROGEN	mg/l	< 0.050
NITRATE NITROGEN	mg/l	1.15
CYANIDE (TOTAL)	mg/l	3.66
DISSOLVED SOLIDS TOTAL	mg/l	3070

Received: 06/30/95 07/14/95 10:55:28

NEVADA GOLDFIELDS, INC.

NOTES:

X - INDICATES A MATRIX INTERFERENCE WHICH MAY REQUIRE A DILUTION OR WHICH PREVENTS THE REPORTING OF A RESULT. DETECTION LIMITS HAVE BEEN ADJUSTED WHERE APPLICABLE.

4500311, 1506012

DAVIS & FLOYD

Chain of Custody Form

Page ___ of ___

816 East Durst Street, Greenwood, S.C. 29649 Phone (803)229-5211 Fax (803)229-7119

PROJ. NO.: 756100

PROJECT NAME: Nevada Goldfields

SAMPLERS NAME/AFFILIATION:(PRINTED): JOHN MCMAHAN

CONTAINERS (PARAMETERS ON BACK): 1 1000ml P; 2 1000 250ml P; 3 125ml G; 4 250ml P; 5 1 Gal P; 6 1000ml P; 7 125ml P; 8; 9; 10; 11; 12; 13; 14; 15

SAMPLE NO.	DATE	GRAB	TIME	COMP.	TIME ON	TIME OFF	SAMPLE DESCRIPTION	NO. OF BOTTLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	SAMPLE TYPE	POTENTIAL HAZARD
	6-29-95	X	1030				GW-1	7	1	1	1	1	1	1	1									GW	
		X	1146				GW-3	7	1	1	1	1	1	1	1									GW	
		X	1253				P	7	1	1	1	1	1	1	1									GW	
		X	1331				K	7	1	1	1	1	1	1	1									GW	
		X	1357				J	7	1	1	1	1	1	1	1									GW	
		X	1503				I	7	1	1	1	1	1	1	1									GW	
		X	1615				H	7	1	1	1	1	1	1	1									GW	
		X	165				H Dup	7	1	1	1	1	1	1	1									GW	
	↓	X	1653				Main Pit	7	1	1	1	1	1	1	1									GW	

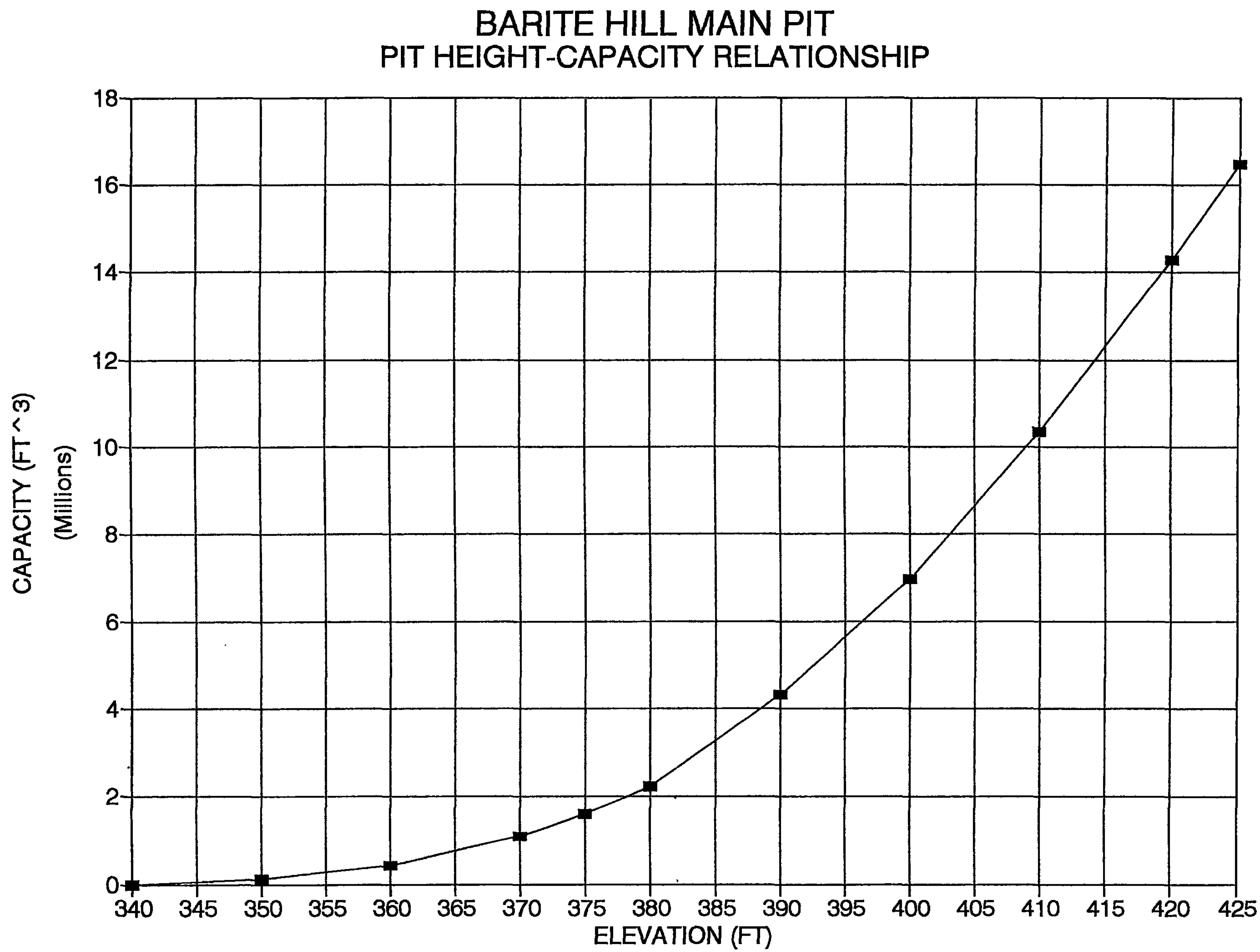
RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)
John L. McMahan II	6-30-95 / 0816				

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED FOR LAB BY: (SIGNATURE)	DATE / TIME	CLIENT CONTACT:
		Tracey W. Capell	6-30-95 / 8:16	RESULTS SENT TO: DATE:

DW-DRINKING WATER WW-WASTE WATER HW-HAZARDOUS WATER SD-SOLID AB-ABSORBENT TUBE
GW-GROUND WATER RC-RCRA SW-SURFACE WATER IM-IMPINGER SOLUTION F -FILTERS

07/20/95 12:20 ☎803443 2187 NEVADA GOLDFIELD ☑006

APPENDIX B
MAIN PIT HEIGHT VS CAPACITY RELATIONSHIP


BARITE HILL MAIN PIT
PIT HEIGHT-CAPACITY RELATIONSHIP
CAPACITY (FT ^3)
(Millions)
0
2
4
6
8
10
12
14
16
18
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420
425
ELEVATION (FT)

APPENDIX C
LABORATORY TEST DATA

ACZ

Analytical Results

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Steffen Robertson And Kirsten
3232 S. Vance St. Suite 210
Lakewood, CO 80227
Gene Muller

Lab Sample ID: *L6823-04*
Client Sample ID: *14115-P-CaOH*
Client Project ID:
ACZ Report ID: *RG14541*

Date Sampled: *8/15/95 00:00*
Date Received: *8/16/95*
Date Reported: *9/8/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP		U	mg/L	0.06	0.3	9/6/95	rd
Arsenic, total	M206.2 GFAA		U	mg/L	0.001	0.006	9/7/95	sh
Barium, total	M200.7 ICP	0.009	B	mg/L	0.006	0.02	9/6/95	rd
Cadmium, total	M200.7 ICP		U	mg/L	0.006	0.03	9/6/95	rd
Calcium, total	M200.7 ICP	279.0		mg/L	0.4	2	9/6/95	rd
Copper, total	M200.7 ICP	1.32		mg/L	0.02	0.1	9/6/95	rd
Iron, total	M200.7 ICP	0.09	B	mg/L	0.02	0.1	9/6/95	rd
Lead, total	M200.7 ICP		U	mg/L	0.04	0.2	9/6/95	rd
Manganese, total	M200.7 ICP	0.04	B	mg/L	0.01	0.05	9/6/95	rd
Nickel, total	M200.7 ICP	0.11		mg/L	0.02	0.1	9/6/95	rd
Selenium, total	SM 3500-Se C, AA-Hydride	0.71		mg/L	0.04	0.2	8/22/95	rs
Silver, total	M200.7 ICP		U	mg/L	0.01	0.05	9/6/95	rd
Zinc, total	M200.7 ICP	0.14		mg/L	0.02	0.1	9/6/95	rd

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						8/29/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						8/29/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1		U	mg/L	2	10	8/17/95	kh
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3			U	mg/L	2	10	8/24/95	kh
Carbonate as CaCO3		40		mg/L	2	10	8/24/95	kh
Hydroxide as CaCO3		101		mg/L	2	10	8/24/95	kh
Total Alkalinity		141		mg/L	2	10	8/24/95	kh
Lab Filtration	***						8/17/95	kh
pH (lab)	M150.1 - Electrometric	11.1		units	0.1	0.1	8/17/95	kh
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	2800		mg/L	10	20	8/18/95	ko
Sulfate -	M375.3 - Gravimetric	1700		mg/L	100	200	8/23/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Halcunehl for RVP

Vice President of Operations: Ralph Poulsen

ACZ

Analytical Results

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Steffen Robertson And Kirsten
3232 S. Vance St. Suite 210
Lakewood, CO 80227
Gene Muller

Lab Sample ID: *L6823-01*
Client Sample ID: *14115-P-TSP*
Client Project ID:
ACZ Report ID: *RG14538*

Date Sampled: *8/15/95 00:00*
Date Received: *8/16/95*
Date Reported: *9/8/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP		U	mg/L	0.06	0.3	9/6/95	rd
Arsenic, total	M206.2 GFAA	0.002	B	mg/L	0.001	0.006	9/7/95	sh
Barium, total	M200.7 ICP		U	mg/L	0.006	0.02	9/6/95	rd
Cadmium, total	M200.7 ICP	0.216		mg/L	0.006	0.03	9/6/95	rd
Calcium, total	M200.7 ICP	54.6		mg/L	0.4	2	9/6/95	rd
Copper, total	M200.7 ICP	0.42		mg/L	0.02	0.1	9/6/95	rd
Iron, total	M200.7 ICP	0.17		mg/L	0.02	0.1	9/6/95	rd
Lead, total	M200.7 ICP		U	mg/L	0.04	0.2	9/6/95	rd
Manganese, total	M200.7 ICP	3.88		mg/L	0.01	0.05	9/6/95	rd
Nickel, total	M200.7 ICP	0.26		mg/L	0.02	0.1	9/6/95	rd
Selenium, total	SM 3500-Se C, AA-Hydride	1.03		mg/L	0.04	0.2	8/22/95	rs
Silver, total	M200.7 ICP		U	mg/L	0.01	0.05	9/6/95	rd
Zinc, total	M200.7 ICP	3.63		mg/L	0.02	0.1	9/6/95	rd

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						8/29/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						8/29/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1	75		mg/L	2	10	8/17/95	kh
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3		15		mg/L	2	10	8/24/95	kh
Carbonate as CaCO3			U	mg/L	2	10	8/24/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/24/95	kh
Total Alkalinity		15		mg/L	2	10	8/24/95	kh
Lab Filtration	***						8/17/95	kh
pH (lab)	M150.1 - Electrometric	6.0		units	0.1	0.1	8/17/95	kh
Phosphorus, total	M365.1-Automated Ascorbic Acid (dige	17.30		mg/L	0.05	0.3	8/19/95	ss
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	2770		mg/L	10	20	8/18/95	ko
Sulfate	M375.3 - Gravimetric	2100		mg/L	100	200	8/21/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Holcomb for RVP
Vice President of Operations: Ralph Poulsen

ACZ

Analytical Results

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Lab Sample ID: *L6823-03*
Client Sample ID: *14115-P-NaOH*
Client Project ID:
ACZ Report ID: *RG14540*

Steffen Robertson And Kirsten
3232 S. Vance St. Suite 210
Lakewood, CO 80227
Gene Muller

Date Sampled: *8/15/95 00:00*
Date Received: *8/16/95*
Date Reported: *9/8/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP	0.08	B	mg/L	0.06	0.3	9/6/95	rd
Arsenic, total	M206.2 GFAA		U	mg/L	0.001	0.006	9/7/95	sh
Barium, total	M200.7 ICP	0.010	B	mg/L	0.006	0.02	9/6/95	rd
Cadmium, total	M200.7 ICP	0.213		mg/L	0.006	0.03	9/6/95	rd
Calcium, total	M200.7 ICP	77.2		mg/L	0.4	2	9/6/95	rd
Copper, total	M200.7 ICP	3.55		mg/L	0.02	0.1	9/6/95	rd
Iron, total	M200.7 ICP	0.48		mg/L	0.02	0.1	9/6/95	rd
Lead, total	M200.7 ICP		U	mg/L	0.04	0.2	9/6/95	rd
Manganese, total	M200.7 ICP	5.22		mg/L	0.01	0.05	9/6/95	rd
Nickel, total	M200.7 ICP	0.07	B	mg/L	0.02	0.1	9/6/95	rd
Selenium, total	SM 3500-Se C, AA-Hydride	1.07		mg/L	0.04	0.2	8/22/95	rs
Silver, total	M200.7 ICP		U	mg/L	0.01	0.05	9/6/95	rd
Zinc, total	M200.7 ICP	0.41		mg/L	0.02	0.1	9/6/95	rd

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						8/29/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						8/29/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1		U	mg/L	2	10	8/17/95	kh
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3		30		mg/L	2	10	8/24/95	kh
Carbonate as CaCO3		20		mg/L	2	10	8/24/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/24/95	kh
Total Alkalinity		50		mg/L	2	10	8/24/95	kh
Lab Filtration	***						8/17/95	kh
pH (lab)	M150.1 - Electrometric	8.6		units	0.1	0.1	8/17/95	kh
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	2980		mg/L	10	20	8/18/95	ko
Sulfate	M375.3 - Gravimetric	2000		mg/L	100	200	8/23/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Habermehl for RVP
Vice President of Operations: Ralph Poulsen

ACZ

Analytical Results

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Steffen Robertson And Kirsten
3232 S. Vance St. Suite 210
Lakewood, CO 80227
Gene Muller

Lab Sample ID: *L6877-04*
Client Sample ID: *14115-WR-KD*
Client Project ID: *COC 01592*
ACZ Report ID: *RG14890*

Date Sampled: *8/18/95 00:00*
Date Received: *8/21/95*
Date Reported: *9/13/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP	5.52		mg/L	0.05	0.3	9/13/95	fp
Arsenic, total	M206.2 GFAA	0.38		mg/L	0.02	0.1	9/11/95	sh
Barium, total	M200.7 ICP	1.540		mg/L	0.005	0.02	9/13/95	fp
Cadmium, total	M200.7 ICP		U	mg/L	0.005	0.03	9/13/95	fp
Calcium, total	M200.7 ICP	576.0		mg/L	0.4	2	9/13/95	fp
Copper, total	M200.7 ICP	0.38		mg/L	0.02	0.09	9/13/95	fp
Iron, total	M200.7 ICP	19.80		mg/L	0.02	0.09	9/13/95	fp
Lead, total	M200.7 ICP	0.28		mg/L	0.04	0.2	9/13/95	fp
Manganese, total	M200.7 ICP	1.300		mg/L	0.009	0.05	9/13/95	fp
Nickel, total	M200.7 ICP	0.03	B	mg/L	0.02	0.09	9/13/95	fp
Selenium, total	SM 3500-Se C, AA-Hydride	0.27		mg/L	0.02	0.1	8/23/95	rs
Silver, total	M200.7 ICP	0.022	B	mg/L	0.009	0.05	9/13/95	fp
Zinc, total	M200.7 ICP	1.75		mg/L	0.02	0.09	9/13/95	fp

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						9/7/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						9/7/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1		U	mg/L	2	10	9/1/95	ko
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3		392		mg/L	2	10	8/25/95	kh
Carbonate as CaCO3			U	mg/L	2	10	8/25/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/25/95	kh
Total Alkalinity		392		mg/L	2	10	8/25/95	kh
Conductivity @25C	M120.1 - Meter	8240		umhos/cm	1	10	9/13/95	jk
Lab Filtration	***						8/23/95	kh
pH (lab)	M150.1 - Electrometric	4.1		units	0.1	0.1	8/22/95	ko
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	8360		mg/L	10	20	8/22/95	kh
Sulfate	M375.3 - Gravimetric	3500		mg/L	100	200	8/23/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Halcumehl for RVP
Vice President of Operations: Ralph Poulsen

ACZ **Analytical Results**

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Lab Sample ID: *L6877-03*
Client Sample ID: *14115-WR-SL*
Client Project ID: *COC 01592*
ACZ Report ID: *RG14889*

Steffen Robertson And Kirsten
3232 S. Vance St. Suite 210
Lakewood, CO 80227
Gene Muller

Date Sampled: *8/18/95 00:00*
Date Received: *8/21/95*
Date Reported: *9/13/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP	26.10		mg/L	0.05	0.3	9/13/95	fp
Arsenic, total	M206.2 GFAA	0.50		mg/L	0.02	0.1	9/11/95	sh
Barium, total	M200.7 ICP	1.700		mg/L	0.005	0.02	9/13/95	fp
Cadmium, total	M200.7 ICP	0.076		mg/L	0.005	0.03	9/13/95	fp
Calcium, total	M200.7 ICP	489.0		mg/L	0.4	2	9/13/95	fp
Copper, total	M200.7 ICP	3.38		mg/L	0.02	0.09	9/13/95	fp
Iron, total	M200.7 ICP	99.70		mg/L	0.02	0.09	9/13/95	fp
Lead, total	M200.7 ICP	0.46		mg/L	0.04	0.2	9/13/95	fp
Manganese, total	M200.7 ICP	5.750		mg/L	0.009	0.05	9/13/95	fp
Nickel, total	M200.7 ICP	0.28		mg/L	0.02	0.09	9/13/95	fp
Selenium, total	SM 3500-Se C, AA-Hydride	0.18		mg/L	0.02	0.1	8/23/95	rs
Silver, total	M200.7 ICP	0.016	B	mg/L	0.009	0.05	9/13/95	fp
Zinc, total	M200.7 ICP	22.60		mg/L	0.02	0.09	9/13/95	fp

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						9/7/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						9/7/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1	195		mg/L	2	10	9/1/95	ko
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3			U	mg/L	2	10	8/25/95	kh
Carbonate as CaCO3			U	mg/L	2	10	8/25/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/25/95	kh
Total Alkalinity			U	mg/L	2	10	8/25/95	kh
Conductivity @25C	M120.1 - Meter	5980		umhos/cm	1	10	9/13/95	jk
Lab Filtration	***						8/23/95	kh
pH (lab)	M150.1 - Electrometric	5.5		units	0.1	0.1	8/22/95	ko
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	6560		mg/L	10	20	8/22/95	kh
Sulfate	M375.3 - Gravimetric	3900		mg/L	200	400	8/23/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Habermehl for RVP
Vice President of Operations: Ralph Poulsen

ACZ

Analytical Results

ACZ Laboratories, Inc.
30400 Downhill Drive
Steamboat Springs, CO 80487
(800) 334-5493

Steffen Robertson And Kirsten
3232 S. Vance St. Suite 210
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Gene Muller

Lab Sample ID: *L6877-02*
Client Sample ID: *14115-WR-NAOH*
Client Project ID: *COC 01592*
ACZ Report ID: *RG14888*

Date Sampled: *8/18/95 00:00*
Date Received: *8/21/95*
Date Reported: *9/13/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP	13.60		mg/L	0.03	0.2	9/13/95	fp
Arsenic, total	M206.2 GFAA	0.02	B	mg/L	0.01	0.06	9/11/95	sh
Barium, total	M200.7 ICP	1.190		mg/L	0.003	0.01	9/13/95	fp
Cadmium, total	M200.7 ICP	0.041		mg/L	0.003	0.02	9/13/95	fp
Calcium, total	M200.7 ICP	252.0		mg/L	0.2	1	9/13/95	fp
Copper, total	M200.7 ICP	1.66		mg/L	0.01	0.05	9/13/95	fp
Iron, total	M200.7 ICP	44.40		mg/L	0.01	0.05	9/13/95	fp
Lead, total	M200.7 ICP	0.25		mg/L	0.02	0.1	9/13/95	fp
Manganese, total	M200.7 ICP	6.240		mg/L	0.005	0.03	9/13/95	fp
Nickel, total	M200.7 ICP	0.14		mg/L	0.01	0.05	9/13/95	fp
Selenium, total	SM 3500-Se C, AA-Hydride	0.49		mg/L	0.02	0.1	8/23/95	rs
Silver, total	M200.7 ICP	0.031		mg/L	0.005	0.03	9/13/95	fp
Zinc, total	M200.7 ICP	16.00		mg/L	0.01	0.05	9/13/95	fp

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						9/7/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						9/7/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1	80		mg/L	2	10	9/1/95	ko
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3		15		mg/L	2	10	8/25/95	kh
Carbonate as CaCO3			U	mg/L	2	10	8/25/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/25/95	kh
Total Alkalinity		15		mg/L	2	10	8/25/95	kh
Conductivity @25C	M120.1 - Meter	57000		umhos/cm	1	10	9/13/95	jk
Lab Filtration	***						8/23/95	kh
pH (lab)	M150.1 - Electrometric	6.3		units	0.1	0.1	8/22/95	ko
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	67200		mg/L	10	20	8/22/95	kh
Sulfate	M375.3 - Gravimetric	45900		mg/L	200	400	8/23/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Halcumehl for RVP
Vice President of Operations: Ralph Poulsen

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Lab Sample ID: *L6877-01*
Client Sample ID: *14115-WR-TSP*
Client Project ID: *COC 01592*
ACZ Report ID: *RG14887*

Date Sampled: *8/18/95 00:00*
Date Received: *8/21/95*
Date Reported: *9/13/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP	10.30		mg/L	0.03	0.2	9/13/95	fp
Arsenic, total	M206.2 GFAA	0.02	B	mg/L	0.01	0.06	9/11/95	sh
Barium, total	M200.7 ICP	0.896		mg/L	0.003	0.01	9/13/95	fp
Cadmium, total	M200.7 ICP	0.017		mg/L	0.003	0.02	9/13/95	fp
Calcium, total	M200.7 ICP	103.0		mg/L	0.2	1	9/13/95	fp
Copper, total	M200.7 ICP	0.49		mg/L	0.01	0.05	9/13/95	fp
Iron, total	M200.7 ICP	23.20		mg/L	0.01	0.05	9/13/95	fp
Lead, total	M200.7 ICP	0.25		mg/L	0.02	0.1	9/13/95	fp
Manganese, total	M200.7 ICP	3.240		mg/L	0.005	0.03	9/13/95	fp
Nickel, total	M200.7 ICP	0.59		mg/L	0.01	0.05	9/13/95	fp
Selenium, total	SM 3500-Se C, AA-Hydride	0.36		mg/L	0.02	0.1	8/23/95	rs
Silver, total	M200.7 ICP	0.012	B	mg/L	0.005	0.03	9/13/95	fp
Zinc, total	M200.7 ICP	8.51		mg/L	0.01	0.05	9/13/95	fp

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						9/7/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						9/7/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1	80		mg/L	2	10	9/1/95	ko
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3		236		mg/L	2	10	8/25/95	kh
Carbonate as CaCO3			U	mg/L	2	10	8/25/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/25/95	kh
Total Alkalinity		236		mg/L	2	10	8/25/95	kh
Conductivity @25C	M120.1 - Meter	48000		umhos/cm	1	10	9/13/95	jk
Lab Filtration	***						8/23/95	kh
pH (lab)	M150.1 - Electrometric	7.6		units	0.1	0.1	8/22/95	ko
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	52300		mg/L	10	20	8/22/95	kh
Sulfate	M375.3 - Gravimetric	35300		mg/L	200	400	8/23/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

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Vice President of Operations: Ralph Poulsen

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Lab Sample ID: *L6823-02*
Client Sample ID: *14115-P-KD*
Client Project ID:
ACZ Report ID: *RG14539*

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Date Sampled: *8/15/95 00:00*
Date Received: *8/16/95*
Date Reported: *9/8/95*

Sample Matrix: *Waste Water*

Metals Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Aluminum, total	M200.7 ICP		U	mg/L	0.06	0.3	9/6/95	rd
Arsenic, total	M206.2 GFAA		U	mg/L	0.001	0.006	9/7/95	sh
Barium, total	M200.7 ICP	0.041		mg/L	0.006	0.02	9/6/95	rd
Cadmium, total	M200.7 ICP	0.650		mg/L	0.006	0.03	9/6/95	rd
Calcium, total	M200.7 ICP	262.0		mg/L	0.4	2	9/6/95	rd
Copper, total	M200.7 ICP	2.53		mg/L	0.02	0.1	9/6/95	rd
Iron, total	M200.7 ICP	5.09		mg/L	0.02	0.1	9/6/95	rd
Lead, total	M200.7 ICP		U	mg/L	0.04	0.2	9/6/95	rd
Manganese, total	M200.7 ICP	5.41		mg/L	0.01	0.05	9/6/95	rd
Nickel, total	M200.7 ICP	0.28		mg/L	0.02	0.1	9/6/95	rd
Selenium, total	SM 3500-Se C, AA-Hydride	1.06		mg/L	0.08	0.4	8/22/95	rs
Silver, total	M200.7 ICP		U	mg/L	0.01	0.05	9/6/95	rd
Zinc, total	M200.7 ICP	10.20		mg/L	0.02	0.1	9/6/95	rd

Metals Prep

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Total Digestion	M3015 ICP						8/29/95	jw
Total Metals Digestion	M3015 Metals Digestion(GFAA)						8/29/95	jw

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1	40		mg/L	2	10	8/17/95	kh
Alkalinity as CaCO3	M310.1							
Bicarbonate as CaCO3		15		mg/L	2	10	8/24/95	kh
Carbonate as CaCO3			U	mg/L	2	10	8/24/95	kh
Hydroxide as CaCO3			U	mg/L	2	10	8/24/95	kh
Total Alkalinity		15		mg/L	2	10	8/24/95	kh
Lab Filtration	***						8/17/95	kh
pH (lab)	M150.1 - Electrometric	6.5		units	0.1	0.1	8/17/95	kh
Residue, Filterable (TDS) @180C	M160.1 - Gravimetric	3260		mg/L	10	20	8/18/95	ko
Sulfate	M375.3 - Gravimetric	2500		mg/L	100	200	8/21/95	jk

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

S. Habermehl for RVP
Vice President of Operations: Ralph Poulsen

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Gene Muller

Lab Sample ID: *L6423-01*
Client Sample ID: *14115-GRR1*
Client Project ID: *14115*
ACZ Report ID: *RG12249*

Date Sampled: *7/11/95 00:00*
Date Received: *7/12/95*
Date Reported: *7/31/95*

Sample Matrix: *Soil*

Soil Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Neutralization Potential as CaCO3	M600 2-78-054 3.	50.0		%	0.1	0.5	7/26/95	mc
Solids, Percent	CLPSOW390, PART F, D-98	79.2		%	0.1	0.5	7/26/95	mc

L 500 T/KT CaCO3 Equiv

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

Ralph V. Poulsen
Vice President of Operations: Ralph Poulsen

ACZ Analytical Results

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Lab Sample ID: *L6423-02*
Client Sample ID: *14115SNX1*
Client Project ID: *14115*
ACZ Report ID: *RG12250*

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Date Sampled: *7/11/95 00:00*
Date Received: *7/12/95*
Date Reported: *7/31/95*

Sample Matrix: *Soil*

Soil Analysis

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Neutralization Potential as CaCO3	M600 2-78-054 3.	55.0		%	0.1	0.5	7/26/95	mc
Solids, Percent	CLPSOW390, PART F, D-98	49.2		%	0.1	0.5	7/26/95	mc

550 T/KT $CaCO_3$ Eq

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

Ralph V. Poulsen
Vice President of Operations: Ralph Poulsen

ACZ

Analytical Results

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Lab Sample ID:	L6574-01
Client Sample ID:	BH Pit-1
Client Project ID:	Barite Hill, #14115
ACZ Report ID:	RG12835

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Date Sampled:	7/25/95 00:00
Date Received:	7/26/95
Date Reported:	8/10/95
Sample Matrix:	Surface Water

Wet Chemistry

Parameter	EPA Method	Result	Qual	Units	MDL	PQL	Date	Analyst
Acidity as CaCO3	M305.1	447		mg/L	2	10	8/9/95	kh

From bulk pit water sample
Received July 1995

Inorganic Qualifiers (based on EPA CLP 3/90)
U = Analyte was analyzed for but not detected at the indicated MDL
B = Analyte concentration detected at a value between MDL and PQL
PQL = Practical Quantitation Limit

Ralph V. Poulsen

Vice President of Operations: Ralph Poulsen

4.0 ENVIRONMENTAL REQUIREMENTS

4.1 Control of Sediment

During the performance of the work defined by the Specifications or any operations appurtenant thereto, the Contractor shall provide all labor, equipment, material and means required to control erosion within the work areas and storm runoff sediment generation. The Contractor shall retain sediment at the construction site to the greatest degree possible through the adoption of "best management practices" (BMP's). The BMP's shall be utilized in addition to the erosion control measures defined in the Drawings. The BMP's may consist of, but are not restricted to, the following measures; silt fences, hay bale sediment traps, earth dikes, and diversions. These and other BMP's are described in detail in the report titled "Erosion and Sediment Control for Developing Areas" published by the South Carolina Land Resources Conservation Commission, Erosion and Sediment Control Division, and in the EPA guidance document entitled "Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices" available from the National Technical Information Service (NTIS).

4.2 Control of Fugitive Dust

During the performance of the work defined by these Specifications or any operations appurtenant thereto, whether on right-of-way provided by the Owner or elsewhere, the Contractor shall furnish all labor, equipment, materials, and means required, and shall perform proper and efficient measures wherever and as required to reduce the dust nuisance, and to prevent dust which has originated from the Contractor's operations from damaging land, vegetation, and dwellings, or causing a nuisance to persons. Dust shall be controlled to a degree acceptable to the appropriate regulatory agencies, and acceptable to the Construction Manager.

4.3 Limits of Work

The Contractor shall confine his equipment, apparatus, the storage of materials, and the operation of workmen to limits indicated by law, ordinances, permits or selected by the Construction Manager, and shall not unreasonably encumber the premises with his materials. Extreme caution shall be exercised at all times to avoid blocking plant or other roads or in any other way interfering with the Owner's operations or presenting a hazard to the Owner's personnel and equipment, or to the public.

4.4 Surface Water Control

Prior to beginning construction, the Contractor shall submit for approval a plan showing his proposed method for collection and disposition of surface waters that may affect the execution and completion of work. The plan may be placed in operation upon review and comment by the Construction Manager and Quality Assurance Inspector, but nothing in this section shall relieve the Contractor from full responsibility for the adequacy of the system.

Surface water control shall be accomplished in a manner that will result in all construction operations being performed free of excess moisture. The Contractor shall provide dewatering or surface diversions, as needed, at his own expense to maintain drained conditions. It shall be the Contractor's responsibility to protect his equipment and materials, as well as completed work or portions of the work in progress from damage in the event of such storms.

The Contractor shall sequence his construction activities to minimize erosion or runoff damage to the earthworks covered under these Specifications. In the event neglect or poor construction planning results in damage to the facilities constructed or being constructed, the facilities shall be repaired or replaced to the satisfaction of the Construction Manager, at the Contractor's expense. Plans for remedial work shall be submitted by the Contractor for review and approval by the Construction Manager prior to commencement of such work.

5.0 EXCAVATION

5.1 General

5.1.1 Scope of Work

The excavations to be performed include, but are not limited to regrading of pit walls, development of project borrow areas and drainage cut excavation.

There shall be no classification of soil and rock excavations for these Specifications as to type, hardness, moisture condition or other characteristics affecting excavatability. The Contractor shall be solely responsible for determining the excavatability of soil and rock materials, water table conditions and other pertinent subsurface information.

5.1.2 Handling of Material

Insofar as is practicable in the permanent construction, the Contractor shall use materials obtained from required excavations and approved borrow areas which meet applicable specifications. Such materials may be placed in the designated final locations direct from the excavation, or may be placed in temporary stockpiles and later placed in the final location as approved by the Construction Manager. The Contractor shall schedule excavation operations so as to avoid or minimize stockpiling and rehandling of excavated material.

5.1.3 Lines and Grades

All open-cut excavations shall be performed in accordance with the Specifications to the lines, grades, and dimensions shown on the Drawings or as established by the Design Engineer or Construction Manager. Assumed excavation lines for the work are shown on the Drawings, but the final excavation may vary from the lines shown. The assumed final lines for excavation, shown on the Drawings, shall not be strictly interpreted as accurately indicating the final or actual lines of excavation. When unfavorable conditions are discovered, they shall be corrected by excavation to lines, depths, and dimensions prescribed by the Design Engineer or Construction Manager.

Unless noted otherwise or specifically prescribed by the Design Engineer or Construction Manager, the maximum permissible deviation from specified lines and grades shall be plus or minus 0.25 feet.

5.1.4 Cuts and Slopes

The Contractor shall inspect all temporary and permanent open-cut excavations on a regular basis for signs of instability. Should signs of instability be noted, the Contractor shall undertake remedial measures immediately and shall notify the Construction Manager as soon as possible. It will be the Contractor's responsibility to remove all loose material from the excavation slopes and to maintain the slopes in a safe and stable condition at all times during the progress of the work.

5.1.5 Excess Excavation

All necessary precautions shall be taken to preserve the material below and beyond the lines of excavation in the soundest possible condition. Where excess excavation has been performed to complete the work, such areas shall be refilled with materials furnished and placed to the satisfaction of the Construction Manager.

5.1.6 Disposal of Excavated Materials

5.2 Site Preparation

Site preparation activities shall consist of clearing, grubbing, and stripping for the fill areas. Limited clearing, stripping and grubbing operations will be required on the periphery of the pit area. Clearing involves removal of surface vegetation by a method that mulches the vegetation for inclusion in the topsoil stockpile. Clearing also involves removing any rubbish or debris unsuitable for inclusion with topsoil materials, as determine by the Quality Assurance Inspector, and isolating this material from other materials for proper disposal. Grubbing involves removal of brush and tree roots in excess of ½ inch in diameter in the subsoils. Stripping involves removal of organic soils, or otherwise unsuitable foundation materials, as determined by the Quality Assurance Inspector. An organized topsoil stripping pattern with grade stakes shall be implemented by the Contractor as approved by the Quality Assurance Inspector to ensure that topsoil is removed without over excavation. Clearing, grubbing, and stripping limits shall extend 5 ft beyond the construction work area.

The vegetative and topsoil materials removed during clearing, grubbing and stripping shall be removed and stored in topsoil stockpile areas meeting the approval of the Construction Manager. Topsoil stockpiles may be created in small localized stockpiles within or adjacent to areas of disturbance, within pre-existing topsoil stockpiles, or in other areas meeting the Construction Manager's approval. Topsoil stockpiles shall not be placed in areas of concentrated storm run-off, nor blocking access roads, haul roads or other of the Owner's facilities, nor interfere with the Owner's operations or work of other contractors. Topsoil stockpiles shall be placed with maximum side slopes of 3H:1V and surrounded with surface water diversion structures and silt fences meeting the approval of the Quality Assurance Inspector.

Alternatively, topsoil may be placed directly within the areas requiring topsoil placement once these areas have been graded. If handled in this fashion the topsoil must be promptly seeded and covered with mulch as per the Revegetation Specifications.

5.3 Access Roads

Contractor's access roads shall be planned such that construction of said roads shall coincide as much as practicable with the construction of the permanent roads associated with the project and other required excavation. Prior to development of access roads, the Contractor shall submit a plan showing their location and size for the Construction Manager to issue for the Owner's approval.

5.4 Borrow Areas

To the extent practicable, earth and rock materials required for the work defined by these Specifications shall be obtained mandatory excavations and on-site borrow areas designated by the Construction Manager. Materials not available from said borrow areas shall be furnished by the Contractor from a source proposed by the Contractor and approved by the Quality Assurance Inspector. The Owner may elect to furnish any or all borrow from ancillary areas of the property.

The Contractor may select and use any borrow area approved by the Quality Assurance Inspector for construction materials, provided the materials meet the specification requirements for the intended use.

6.0 FILL PLACEMENT

6.1 General

6.1.1 Scope

Pit closure will require waste rock backfill placement, slope regrading and backfill of excavated materials, and soil cover and topsoil placement. Fill materials shall be obtained from approved sites and local borrow areas or imported. Amendment of selected backfill materials with slaked lime will be required. All fill material shall be subject to the approval of the Construction Manager and the Quality Assurance Inspector.

Borrow areas shall be established, as necessary for backfill and soil cover material. The location, physical dimensions, and depth of stripping shall be identified by the Contractor and approved by the Quality Assurance Inspector prior to commencement of work requiring such borrow material. Within borrow areas, cut slopes shall be maintained at 2H:1V or less.

The work covered by this section of the Specifications shall include, but is not limited to backfill placement cover placement. The fill materials shall be categorized as follows:

- Type 1 - Stockpiled waste rock backfill;
- Type 2 - Random backfill;
- Type 3 - Soil cover fill;

6.1.2 Lines and Grades

Fill materials shall be placed to the lines, grades, and cross-sections shown in the Closure Report or as specified herein.

6.1.3 Foundation Preparation

Upon the completion of the required foundation clearing, stripping and excavation operations and removal of unsuitable foundation material, construction area surfaces composed of spent ore, native soil materials, or fill materials shall be scarified to a minimum depth of 12 inches, moisture conditioned to near optimum moisture content, and compacted to at least 95 percent of maximum dry density (ASTM D-698). In areas where the surface is composed of intact rock, fill placement shall be commenced following the completion of clearing or stripping activities. No new fill shall be placed in the foundation areas until the foundation has been inspected and approved by the Quality Assurance Inspector.

6.1.4 Placement

The procedures for the construction of required fills shall be approved by the Quality Assurance Inspector prior to fill placement.

No fill materials shall be placed until the foundation and subgrade preparations, within the area of placement, have been completed and approved by the Quality Assurance Inspector. Subsequent placement of fill shall be made only in areas approved by the Quality Assurance Inspector. Placement of the fill shall be done to the lines and grades shown on the Drawings.

Fill placement procedures and equipment shall be suitable for constructing a relatively uniform fill, meeting minimum density and/or compaction effort requirements, as specified. The Contractor shall dewater or provide drainage for ponded water conditions in fill areas.

No deleterious or unsuitable materials shall be placed in the fills. The suitability of all fill materials intended for use in the construction work shall be subject to approval by the Quality Assurance Inspector. Cover fill placement shall be temporarily stopped, due to unsuitable weather conditions, at the discretion of the Quality Assurance Inspector. Under marginal weather conditions, the Contractor may place fill provided the fill, when tested, meets Specification.

The distribution of materials in the cover fill shall be such that the fill is free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material. The combined borrow excavation and fill placement operation shall be such that the materials, when compacted in the fill, shall be blended sufficiently to secure the best practicable distribution of the material, subject to the approval of the Quality Assurance Inspector.

If, in the opinion of the Quality Assurance Inspector, the surface of the prepared foundation or the surface of any layer of the fill is too dry or too smooth to bond properly with the layer of material to be placed thereon, it shall be moistened and/or worked with harrow, scarifier, or other equipment to provide a satisfactory bonding surface before the next layer of fill material is placed. If, in the opinion of the Quality Assurance Inspector, the surface of the prepared foundation or the rolled surface of any layer of the fill in place is too wet for proper compaction of the layer of fill material to be placed thereon, it shall be removed and allowed to dry or shall be worked with harrow, scarifier, or other equipment to reduce the moisture content to the required amount, and then compacted before the next layer of fill material is placed.

6.1.5 Moisture Control

During compaction operations, cover fill materials shall be maintained or conditioned within the moisture content range required to permit proper compaction to the specified density. The moisture content of the fill material prior to and during compaction shall be uniform throughout the material.

When material is too dry for proper compaction, the Contractor shall spray water on the fill and work the moisture into the fill by harrowing, discing, or other approved means until a uniform distribution of moisture is obtained. Material that is too wet for proper compaction shall be removed from the fill or the material may be spread and permitted to dry, assisted by discing and harrowing, if necessary, until the moisture content is reduced to an amount suitable for obtaining the specified degree of compaction and is relatively uniformly and evenly distributed throughout the fill material.

6.1.6 Compaction

Where necessary, after fill material has been placed and spread, or reworked in-place and moisture conditioned as specified, the fill material shall be compacted by passing compaction equipment over the entire surface of the layer a sufficient number of times to obtain the required density, as determined by the Quality Assurance Inspector on the basis of field density tests and his observation of the fill operations.

The frequency of field density tests performed on the cover fill material shall be as specified in the "Nevada Goldfields Barite Hill Project, QA/QC Program for Closure Cover Placement.

The Quality Assurance Inspector will continuously evaluate the Contractor's equipment and methods. If such equipment or methods are found unsatisfactory for the intended use, the Contractor shall be required to replace the unsatisfactory equipment with other types or adjust methods until proper compaction is achieved.

Compaction shall be based on ASTM D-698 or compaction effort as approved by the Quality Assurance Inspector. In-place fill densities may be determined by the Sand Cone or Nuclear Gauge Methods. The USBR Rapid Method may be used in conjunction with the Standard Proctor Compaction Method to determine percent compaction.

6.17 Conduct of Work

The Contractor shall maintain and protect fills in a condition satisfactory to the Quality Assurance Inspector at all times until the final completion and acceptance of the work. Any approved fill material which becomes unsuitable for any reason whatsoever, after being placed in the fill and before final acceptance of the work, shall be removed and replaced by the Contractor in a manner satisfactory to the Quality Assurance Inspector.

6.2 Fill Materials

6.2.1 Material Type 1 - Waste Rock Backfill

The Type fill material shall be derived from the waste rock stockpiles areas adjacent to the Main Pit. The Type 1 fill shall be amended with slaked lime at a rate of 2.8 percent by weight unless directed to increase amendment addition rates by the Owner. The amendment shall be placed on the surface of the Type 1 fill and blended by dozer spreading and grading to produce the specified amendment rate. The Type 1 fill will be backfilled in the Main Pit pond by dozer spreading and/or end dumping. Upon completion of amending and backfilling of the Type 1 fill, The Contractor shall level the surface of the completed Type 1 fill.

The Type 1 fill shall be placed within residual water contained in the Main Pit. The Type 1 fill shall be placed without restriction on lift thickness, density or moisture content.

6.2.2 Material Type 2 - Random Backfill

The Type 2 fill shall be derived from the clay borrow area and/or from mandatory excavations undertaken for pit wall slope reduction. The material shall be placed over the Type 1 waste rock backfill and shall be used as a foundation for the Type 3 cover fill.

The Type 2 fill shall be spread in 5-foot maximum loose lifts. The contractor shall route his construction equipment over the surface of each lift to the extent practical to compact the Type 2 fill. The Type 2 fill shall not be subject to moisture conditioning requirements.

Prior to placement of the Type 3 fill over the completed surface of the Type 2 fill, the surface of the Type 2 fill shall be compacted. For materials with physical properties that are within the range of ASTM D698, the Type 2 fill shall be scarified to a depth of 12 inches and compacted to 95 percent of maximum dry density at plus or minus 5 percent of optimum moisture content as determined in accordance with ASTM D698. In situ moisture and density may be determined by nuclear gauge or sand cone methods.

For coarse materials outside the scope of ASTM D-698, the Type 2 fill shall be proof rolled with a loaded haul truck or suitable high contact pressure equipment. Areas exhibit pumping or excessive rutting shall be reworked and compacted, to the satisfaction of the Quality Assurance Inspector, to produce a stable foundation for Type 3 fill placement

6.2.3 Material Type 3 - Soil Cover Fill

The Contractor shall furnish, transport and place Type 3 material to the lines and grades and in the locations shown on the Drawings and set forth in the Specifications, or as specified by the Quality Assurance Inspector. Material Type 3 shall consist of a compacted low-permeability soil cover placed over the entire area of the regraded and backfilled open pit, including the drainage cut area. Type 3 material must extend beyond the limits regrading and backfill placement areas a minimum of 5 feet.

Material Type 3 shall consist of natural fine-grained soil material obtained from on-site borrow sources as directed by the Construction Manager. Type 3 material shall consist of relatively uniform material free of stones, rocks, or blocks and clumps of soil in excess of 4 inches, otherwise no gradation is specified. Type 3 material shall exhibit a maximum permeability of 5×10^{-6} cm/sec when placed and compacted in the manner adopted by the Contractor and as verified by the Quality Assurance Inspector.

Where placed as fill, the Type 3 soil cover fill shall be placed in 12-inch maximum loose lifts and compacted to minimum density of 95 percent of maximum dry density (ASTM D-698) and within plus 5 percent of optimum moisture content. The completed thickness of the Type 3 fill shall be a minimum of 24 inches.

Where suitable materials exist in-place, the Type 3 material shall be scarified to a depth of 12 inches and compacted to 95 percent of maximum dry density at plus or minus 5 percent of optimum moisture content. Both in-place and imported Type 3 fill shall be subject to maximum hydraulic conductivity requirements.

The Contractor shall be responsible for maintaining the integrity of Type 3 soil cover material following placement and prior to acceptance and covering with the next lift or topsoil in the case of the final lift. Any degradation of the Type 3 material which occurs, either from erosion due to storm runoff, excessive moisture uptake or desiccation, shall be rectified at the Contractor's expense. The Contractor shall also be responsible for repairing all perforations of the soil liner including nuclear density device probe holes, BAT permeability test holes, drive tube sample locations, sand-cone holes, permeability sampling locations, and grab sample locations, whether caused by the Contractor's workforce or others. Perforations shall be repaired by backfilling with a soil-bentonite mixture containing not less than 50 percent bentonite by volume. The soil-bentonite mixture shall be tamped in place with a tamping rod, proctor hammer, or hand tamper depending on the size of the perforation.

7.0 RECLAMATION AND REVEGETATION

7.1 General Requirements

The Contractor shall furnish, transport and place all materials required to revegetate all areas disturbed during the construction activities as described herein.

In areas requiring reclamation as specified herein, the Contractor shall place a minimum of 8 inches of topsoil, salvaged during the stripping operations or obtained from topsoil stockpiles at the site, over a prepared subgrade. On steeper slopes, the compacted surface of the Type 3 material may require "dimpling" with a single pass of a sheep-foot roller or track mounted equipment, as directed by the Quality Assurance Inspector, to provide adequate bonding between the topsoil and underlying material. When placed over materials other than the Type 3 cover fill material, topsoil shall be placed over subsoils which have been ripped to a depth of six inches immediately prior to topsoil placement to promote mixing and adhesion of the topsoil to the subsoils. In the case of subsoils requiring amelioration, as directed by the Quality Assurance Inspector, topsoil shall be placed shortly after the subsoils have been amended.

Following topsoil placement, the seed bed shall be prepared by thoroughly mixing 600 lbs/acre of 10/10/10 (Nitrogen/Phosphorus/Potassium) Fertilizer and 1,000 lbs/acre lime into the upper six inches of topsoil by discing or other suitable means. Following topsoil placement and seed bed preparation, the seed mixture in Table 1 shall be drill seeded into the topsoil material. Straw shall be applied at a rate of 1,500 pounds per acre and crimped into the soil with a mechanical crimper immediately following seeding. If seeding is conducted in late fall or winter, the seeded areas will be covered with a top dressing of potassium chloride broadcast at 150 pounds per acre at a rate which will not cause erosion. Immediately following application of the potassium chloride, straw shall be applied at a rate of 1500 lbs per acre and crimped into the soil with a mechanical crimper.

For miscellaneous area of disturbance or newly created earthen areas in natural soil materials (whether insitu or placed as fill), the available topsoil will be placed back over these soils materials and seeded as per these specifications. For reclamation of the regraded, backfilled and covered pit, a minimum of 8 inches of topsoil is required.

TABLE 1 SEEDING RATES		
Seed Type	Topography	
	Flat (lbs/acre)	Slope (lbs/acre)
Lespedeza cuneata Scarified seed (spring/summer) Unscarified seed (fall/winter)	 16 24	 32 48
Fescuta arundinacea	10	20
Paspalum notatum	15	30
Panicum virgatum (fall/winter)	5	10
Lolium multiflorum (fall/winter)	10	20
(spring/summer)	8	16
Notes: 1) Quantities shown are for pounds of pure live seed per acre 2) Seed quantities shown are for drill seeding. If broadcast methods are used, the seeding rate will be doubled.		

When conditions are such by reason of drought, excessive moisture, frozen soil or when in the opinion of the Quality Assurance Inspector or Construction Manager less than satisfactory results are likely to be obtained, seeding work shall be halted as directed and resumed only when conditions are favorable or when approved alternative or corrective measures and procedures have been effected.

The Contractor is to proceed with complete seeding work as rapidly as portions of the site become available, working within seasonal limitations. In any event, seeding shall be accomplished before the prepared seed bed becomes eroded, crusted over or dried out or the seed bed must be re-prepared prior to seeding. At no time shall seed be sown, drilled, or otherwise planted when the surface soil or topsoil is in a frozen or crusted state or during periods of windy weather.

7.2 Seeds

All seed shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, and lot number, net weight, origin, the percent of weed seed content, the guaranteed percentage of purity and germination, and the pounds of Pure Live Seed of each seed species in the container. All brands furnished shall be free from such noxious seeds as Russian or Canadian

Thistle, European Bindweed, Johnson Grass, Leafy Spurge and Old World or Caucasian Bluestem and certified as such by the seed supplier. The Contractor shall furnish to the Quality Assurance Inspector a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory for seed testing within 6 months prior to the date of delivery. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable.

Seed types and amount of pure live seed (PLS) required per acre shall be as called for in Table 1. Seed and seed labels shall conform to all current State and Federal regulations and will be subject to the testing provisions of the Association of Official Seed Analysis. Computations for quantity of pure live seed required are based on the percent of purity and percent of germination received from each seed bag according to the following formula:

Pounds of Seed x (Purity x Germination) = Pounds of Pure Live Seed (PLS).

7.3 Fertilizers

When the use of commercial fertilizer for seeding is called for, it shall consist of a standard form or mixture of standard forms. Agricultural soil sample analyses shall be conducted by the Quality Assurance Inspector once the final soil materials requiring revegetation have been established. Soil amelioration requirements may then be revised and the Contractor's unit rates for these material shall apply.

The forms of commercial fertilizers shown in Table 2 may be used in order to provide the nutrient components required or as directed by the Quality Assurance Inspector, in order to meet the requirements recommended by tests on the soil that is to be used.

Table 2

Material	Minimum % Available Nutrient by Weight		
	N (Nitrogen)	P (Phosphorus)	K (Potassium)
Ammonium Nitrate	33	0	0
Ammonium Sulfate	20	0	0
Urea	45	0	0
Urea formaldehyde	38	0	0
Diammonium Phosphate	18	46	0
Triple Superphosphate	0	46	0

Potash (Muriate of Potassium)	0	0	60
Potassium Chloride	0	0	50

Other forms of commercial fertilizers may be used only upon written request by the Contractor and approval of the Quality Assurance Inspector.

Commercial fertilizer shall conform to the applicable State fertilizer laws. It shall be uniform in composition, dry and free flowing, and shall be delivered to the site with the manufacturer's guaranteed analyses. Fertilizer which becomes caked or otherwise damaged, making it unsuitable for use as determined by the Quality Assurance Inspector, will not be accepted. When called for by the Specifications or Quality Assurance Inspector, fertilizer of the type specified shall be applied uniformly at the rate specified and tilled into the top 6 inches of soil.

The Contractor shall furnish the Quality Assurance Inspector with fertilizer analyses, and bag weights or weigh tickets at the construction site prior to loading the machinery in preparation for fertilizing. No fertilizer shall be placed by the Contractor without the Quality Assurance Inspector's approval.

7.4 Seeding

Preparatory to seeding, the top six inches of the surface shall be tilled and brought to the desired line and grade, except where, in the opinion of the Quality Assurance Inspector, seeding follows so closely behind the initial grading or topsoil placement as to make special seed bed preparation unnecessary. Undulations or irregularities in the surface shall be leveled and existing grass, sod, weeds and seeds must be tilled under.

All slopes 2H:1V and flatter shall be seeded by mechanical power drawn drills followed by packer wheels or drag chains. Mechanical power drawn drills shall have depth banks set to maintain a planting depth of at leach one-quarter inch and not more than one-half inch and shall be set to space the rows not more than 7 inches apart. If inspections indicate that strips wider than the specified space between the rows planted have been left or other areas skipped, the Quality Assurance Inspector may require immediate resowing of seed in such areas at the Contractor's expense. Seed that is extremely small shall be sowed from a separate hopper adjusted to the proper rate of application.

When requested by the Contractor and approved by the Quality Assurance Inspector, seeding may be accomplished by means of approved broadcast or hydraulic type seeders at a rate twice that shown in Table 1. Seeds shall not be drilled or sown or otherwise planted during windy weather or when the ground is frozen, crusted, or otherwise untillable.

All seed sown by broadcast-type seeders shall be "raked in" or otherwise covered with soil to a depth of at least one quarter inch. Hand method of broadcasting seed will be permitted only on small areas not accessible to machine methods.

Seeding of portions of the areas designated may be permitted before the construction is completed in order to take advantage of growing conditions.

7.5 Manure

Manure for soil amelioration shall be barn or stable type animal droppings and shall be free of materials toxic to plant growth and reasonably free of refuse. It shall be well rotted and not have lost its strength by leaching or injurious fermentation. It shall not contain an excess amount of water and be of a consistency for readily mixing with soil to form a broken down or fine mixture.

7.6 Mulching

Materials for straw mulching as specified shall consist of straw of oats, barley, wheat or rye and shall not contain seed of noxious weeds. Straw in such an advance stage of decomposition as to smother or retard the normal growth of seed will not be accepted. Old dry straw which breaks in the crimping process in lieu of bending will not be accepted.

After seeding has been completed, hay or straw shall be uniformly applied at a rate of two tons per acre. The mulch shall then be crimped in with a mechanical crimper or other approved equipment. The Quality Assurance Inspector may order the employment of hand-crimping operations on such areas where excessive ground slopes or confined areas would cause unsatisfactory crimping to result by mechanical methods.

The seeded area shall be mulched and crimped within 24 hours after seeding. Areas not mulched and crimped within 24 hours after seeding must be reseeded with the specified seed mix at the Contractor's expense prior to mulching and crimping.

On slopes steeper than 2:1 or other specific areas which are difficult to mulch and crimp by conventional methods, hydraulic mulching or other means may be used when approved by the Quality Assurance Inspector. If adopted by the Contractor, hydraulic mulch shall consist of wood cellulose fiber mulch.

Wood cellulose fiber for hydraulic mulching shall not contain any substance or factor which might inhibit germination or growth of seed. It shall be dyed an appropriate color to allow visual metering of its application. The wood cellulose fibers shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotter-like ground cover which readily absorbs water, and allows infiltration to the underlying soil. Weight specifications from suppliers, and for all applications, shall refer only to air dry weight of the fiber, a standard equivalent to 10 percent moisture. The mulch material, accompanied with a manufacturer's certification, shall be marked by the manufacturer to show the air dry weight content. Suppliers shall certify that laboratory and field testing of their product has been accomplished, and that it meets all of the foregoing requirements pertaining to wood cellulose fiber mulch.

When required, cellulose fiber mulch shall be added after the proportionate quantities of water and other approved materials have been placed in the slurry tank. All ingredients shall be mixed to form a homogeneous slurry. Using the color of the mulch as a metering agent, the operator shall spray apply the slurry mixture uniformly over the designated seeded area. Unless otherwise ordered for specific areas, wood cellulose fiber mulch shall be applied at the rate of 1500 lbs/acre. If wood fiber hydraulic mulch is utilized, an organic tackifier shall be included in the mulch application at a rate of 100 pounds per acre.

Hydraulic mulching shall not be done in the presence of free surface water resulting from rain, melting snow or other causes.

Areas not properly mulched or areas damaged due to the Contractor's negligence, shall be repaired and remulched in an acceptable manner at the Contractor's expense.

7.7 Post Closure Drainage Cut

The post closure drainage cut will be prepared for seeding as per the above revegetation specifications and seeded at twice the rate specified. Following seeding and mulching, the channel shall be "lined" with jute netting, excelsior blankets, straw or coconut fiber mats, a synthetic erosion liner or other similar materials as approved by the Quality Assurance Inspector. These erosion control mats shall be securely anchored at a maximum spacing of 2 ft with 11-gauge wire staples having a minimum length of 6 inches.

APPENDIX D
HYDROGEOLOGIC COMPUTATIONS

STEFFEN ROBERTSON & KIRSTEN Consulting Engineers & Scientists	PROJECT: Barite Hill	NO. 14115
	CALCULATED BY: KAP	DATE: 9/6/95
	CHECKED BY:	DATE:
	SHEET 1 OF 6	

Purpose: To estimate hydraulic properties of backfill material and rock mass. The values of hydraulic conductivity determined from this analysis will be used to estimate the hydraulic gradient that is likely to exist within the backfill material after mine closure.

Results: Hydraulic conductivity of the backfill material is likely to be similar to that of the surrounding rock mass and the hydraulic gradient within the backfill will probably be similar to the gradient within the rock. ~~Any~~ Estimates of water levels should not ~~assume~~ assume ~~any assumption~~ that the backfilled pit will act as a drain or barrier.

STEFFEN ROBERTSON & KIRSTEN Consulting Engineers & Scientists	PROJECT: Barite Hill		NO. 14115
	CALCULATED BY: KAP		DATE: 9/6/95
	CHECKED BY:		DATE:
	SHEET 2 OF 6		

Methodology:

1. Hydraulic Conductivity Values from Reports:

K_{upper} = 0.05 ft/day (WESTEC, 1992)

K_{middle} = 0.18 ft/day

K_{lower} = 0.019 to 0.09 ft/day

Based on reported values, the average K for the rock mass as a whole could range from 0.019 to 0.18. Waste rock texture is highly variable ranging from silt ~~size~~ to boulders. Due to poor sorting & fine-grained matrix, it would be prudent to estimate K on the low side of the range of hydraulic conductivities. K for waste rock could range from 0.02 to 2.0 ft/day. It may be similar to the weathered ~~upper~~ zone of the rock mass (ie - 0.05 ft/day).

STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers & Scientists

PROJECT: Barite Hill	NO. 14115
CALCULATED BY: KAP	DATE: 9/6/95
CHECKED BY:	DATE:
SHEET 3 OF 6	

II. Estimate of Rock Mass Hydraulic Conductivity from Mine Inflow Rate

Conceptual Model:

Aquifer is infinite in areal extent and unconfined. A reported deep fracture at 180' msl suggests that ~~this~~ secondary permeability must be significant at that level. Water level data indicate that 420' msl would be ~~an~~ a reasonable estimate of initial water level. This would make the saturated thickness 240 ft.

The mine pit in the model is cylindrical. ~~which~~ Its radius and depth increase as mining progresses. The mine is dewatered with a single, fully-penetrating well located at the center of the pit. The pit expands at the same rate as the cone of depression in the water table. At the end of 2 years, the mine has a radius of 300 ft and a depth of 80 ft. A maximum inflow of 20 gpm occurs at this time. The drawdown at the pit boundary is 80 ft

Drawdown at a radius of 300 ft can be estimated through the use of the Theis equation and a drawdown correction to adjust for the effects of dewatering on transmissivity.

Summary of Assumptions:

$r = 300$ ft

$s' = 80$ ft (for unconfined aquifer)

$b = 240$ ft

$t = 730.5$ days

$S = 4 \times 10^{-3}$

$Q = 3850$ ft^3/day

$$s = \frac{s'(2b - s')}{2b}$$ (drawdown correction)

$= 66.67$ ft (for equivalent confined aquifer)

Theis Equation:

$$s = \frac{Q}{4\pi T}\int_u^\infty \frac{e^{-u}}{u}\,du = \frac{Q}{4\pi T}W(u)$$

where: $u = \frac{r^2 S}{4T\tau}$

$W(u)$ is interpolated from Tables.

STEFFEN ROBERTSON & KIRSTEN Consulting Engineers & Scientists	PROJECT: Barite Hill	NO. 14115
	CALCULATED BY: KAP	DATE: 9/6/95
	CHECKED BY:	DATE:
	SHEET 5 OF 6	

Initial guess at $K = 0.2$; $T = 48$

$u \approx 0.003$; $W(u) = 5.23$

$S_{calc} \approx 33.4$ ft

$S_{obs} = 66.7$ ft

Second guess at $K = 0.09$; $T = 22$

$u \approx 0.006$; $W(u) = 4.54$

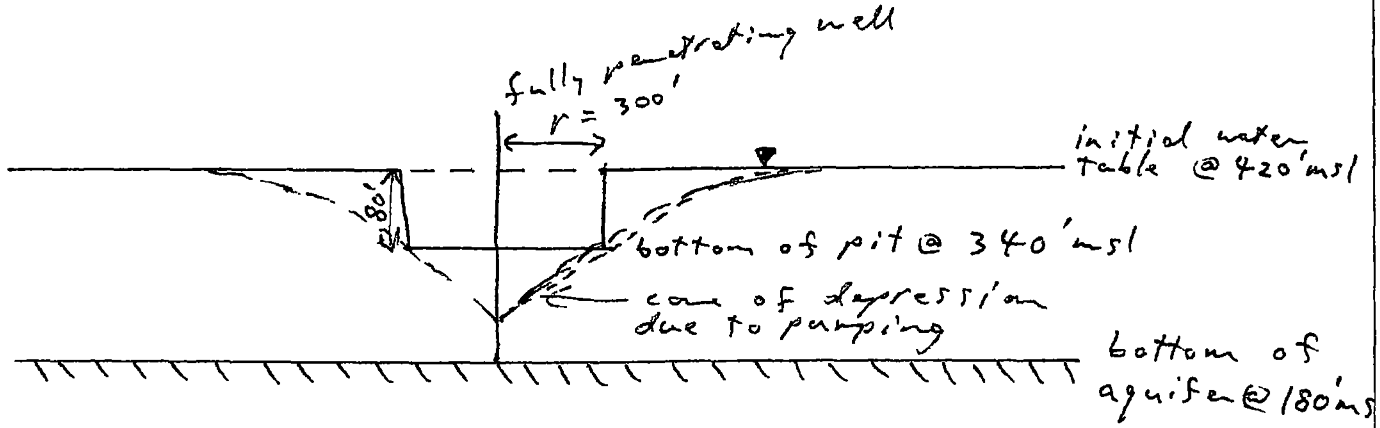
$S_{calc} \approx 64.4$ ft

$S_{obs} = 66.7$ ft close enough

Best estimate of K is about 0.09 ft/day, which is within the range of K from pump tests. Estimate of K for backfill is about 0.05 ft/day.

STEFFEN ROBERTSON & KIRSTEN Consulting Engineers & Scientists	PROJECT: Barite Hill	NO. 14115
	CALCULATED BY: KAP	DATE: 9/6/95
	CHECKED BY:	DATE:
	SHEET 6 OF 6	

Diagram of Conceptual Model:



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****

HYDROLOGICAL SYSTEMS

****

PROGRAM - WASHED

WATERSHED MODELLING

PROGRAM TO DETERMINE RUNOFF HYDROGRAPHS
AND SEDIMENTGRAPHS FOR SMALL CATCHMENTS

****

COMPANY DOING ANALYSIS : SRK
ENGINEER : ROB DOREY
DATE : 24-JUN-96
CLIENT : NEVADA GOLDFIELD
PROJECT DESCRIPTION : BARITE HILL PROJECT
MAJOR WATERSHED NAME : MAIN PIT

THE INPUT DATA FILE IS :BARITE.IN
THE FLOOD HYDROGRAPH AND SEDIMENTGRAPH IS NOT STORED

****
WATERSHED CONDITIONS AT MAIN PIT
****

GLOBAL PARAMETERS

RAINFALL (mm.) : 203.40
INITIAL ABSTRACTION (mm.) : .00
-- will default to the SCS method
TIME INCREMENT OF HYDROGRAPH FROM START OF RUNOFF : .10

RAINFALL DISTRIBUTION SELECTED :SCS TYPE 2 CURVE
==

****
SUBWATERSHED CONDITIONS AT PIT
****

RAINFALL PARAMETERS

SCS CURVE NUMBER : 85.00
UNIT HYDROGRAPH SELECTED : DOUBLE TRIANGLE

MAP PARAMETERS

AREA (ha.) : 9.71
HYDRAULIC LENGTH (m.) : 457.00
PERCENT FOREST (%) : .00
PERCENT AGRICULTURE (%) : .00
PERCENT GRASSLAND (%) : 100.00
OVERLAND FLOW SLOPE (%) : 5.00
CHANNEL SLOPE (%) : 1.00
CHANNEL LENGTH FROM SUBWATERSHED (m.) : 45.00
TYPE OF CHANNEL FROM SUBWATERSHED :AN UNLINED CHANNEL
CORRECTION FACTOR FOR IMPERVIOUS AREA : 1.00
CORRECTION FACTOR FOR CHANNEL IMPROVEMENTS : 1.00
AREAL REDUCTION FACTOR : 1.00

SEDIMENT PARAMETERS

THERE IS NO SEDIMENT DATA FOR THIS SUBWATERSHED

==
===========================

********** STORM HYDROGRAPH GENERATED FROM START OF RAINFALL ***********

TIME *	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
6.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
7.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1
8.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
9.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
10.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
11.0 *	.1	.1	.1	.2	.2	.2	.3	.4	.6	.9
12.0 *	1.4	1.8	2.0	1.9	1.6	1.3	1.1	.9	.8	.8
13.0 *	.8	.8	.8	.7	.7	.7	.7	.7	.6	.6
14.0 *	.6	.6	.6	.5	.5	.4	.4	.4	.4	.3
15.0 *	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2
16.0 *	.2	.2	.2	.2	.2	.2	.1	.1	.1	.1
17.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
18.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
19.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
20.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
21.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
22.0 *	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
23.0 *	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
24.0 *	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
25.0 *	.0	.0	.0							

INITIAL ABSTRACTION = 8.96 mm.
ROUTED FLOW TIME FROM THE SUBWATERSHED = .00 hours.
TIME TO PEAK OF UNIT HYDROGRAPH = .30 hours.
THE DEPTH OF WATER ON WATERSHED = 157.97 mm.
VOLUME OF RUNOFF = 15.33 thousand cu.m.
PEAK RUNOFF RATE = 2.01 cu. m./sec.
TIME TO PEAK RUNOFF = 12.20 hours.

==

THERE IS NO SEDIMENT CONTAINED IN THE STORM RUNOFF FROM THIS

WATERSHED

==

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STORM HYDROGRAPH FOR WATERSHED MAIN PIT

=======================================

TOTAL AREA OF THE WATERSHED = 9.71 ha.
THE DEPTH OF WATER ON WATERSHED = 157.97 mm.
VOLUME OF RUNOFF = 15.33 thousand cu.m.
PEAK RUNOFF RATE = 2.01 cu. m./sec.
TIME TO PEAK RUNOFF = 12.20 hours.
TIME INCREMENT OF NEW HYDROGRAPH = .10 hours.
NUMBER OF RUNOFF VALUES = 210

******* STORM HYDROGRAPH GENERATED FROM START OF RUNOFF ***

.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
.0	.0	.0	.0	.0	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.2	.2	.2	.3	.4	.6	.9	1.4	1.8	2.0
1.9	1.6	1.3	1.1	.9	.8	.8	.8	.8	.8
.7	.7	.7	.7	.7	.6	.6	.6	.6	.6
.5	.5	.4	.4	.4	.4	.3	.3	.3	.3
.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
.2	.2	.2	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
.1	.1	.0	.0	.0	.0	.0	.0	.0	.0

=======================================

Trapezoidal Channel Analysis & Design
Open Channel - Uniform flow

Worksheet Name: Barite Hill

Comment: closure outlet

Solve For Depth

Given Input Data:

Bottom Width.....	10.00 ft
Left Side Slope..	3.00:1 (H:V)
Right Side Slope.	3.00:1 (H:V)
Manning's n......	0.035
Channel Slope....	0.0025 ft/ft
Discharge........	71.00 cfs

Computed Results:

Depth...........	1.81 ft
Velocity.........	2.53 fps
Flow Area........	28.01 sf
Flow Top Width...	20.88 ft
Wetted Perimeter.	21.47 ft
Critical Depth...	1.04 ft
Critical Slope...	0.0195 ft/ft
Froude Number....	0.39 (flow is Subcritical)

APPENDIX E

TECHNICAL SPECIFICATIONS FOR COVER CONSTRUCTION

BARITE HILL PROJECT
TECHNICAL SPECIFICATIONS
FOR MAIN PIT CLOSURE

Prepared for:
Nevada Goldfields, Inc.
P.O. Box 1530
McCormick, South Carolina 29835

Prepared by:
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SRK Project No. 14117

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1.0 INTRODUCTION

1.1 General

These Technical Specifications are for the closure of the Main Pit at the Barite Hill Project located near McCormick, South Carolina.

1.2 Scope of Work

The scope of work for these Technical Specifications shall include all earthwork required for the facility closure and reclamation including backfill amendment and placement, regrading, cover placement and revegetation. Specific work items include, but are not limited to the following:

- Mobilization of all equipment and material required for the work;
- Installation of temporary and permanent surface water control;
- Development of borrow areas outside the construction areas;
- Foundation preparation for cover fill placement;
- Backfill placement and pit wall regrading;
- Drainage cut construction;
- Cover placement and compaction;
- Topsoil placement;
- Seeding and mulching;
- Furnishing and installing all material and constructing all items appurtenant and incidental to the above; and
- Demobilizing, which includes removal of temporary structures and shaping, contouring, grading final surfaces and revegetating these areas.

The Contractor shall familiarize himself with the relevant regional and site specific conditions which may have an impact upon the work. Data relevant to the overall project are contained in reports in the possession of the Owner, which are available for Contractor review. Of particular relevance to the work is the report, "Barite Hill Project, Main Pit Closure Report" (the Closure Report) by Steffen Robertson and Kirsten (U.S.), Inc. (SRK, 1996).

A significant part of the earthworks for the facility will involve regrading, placement and compaction of clay borrow material within the main pit. This work will involve regrading the existing pit walls to 3H:1V slopes. In the case of discrepancy or ambiguity in the Specifications, codes, standards, or regulations, it is the intent of these Specifications that the most restrictive interpretation shall apply unless interpreted otherwise by the Design Engineer.

1.3 Definitions

The following definitions apply to these Specifications.

a. "Owner" is defined as an authorized representative of Nevada Goldfields, Inc. (NGI);

b. "Construction Manager" is defined as an authorized representative of the Owner responsible for coordinating the activities of the Contractor;

c. "Quality Assurance Inspector" is defined as a qualified representative appointed and authorized by the Owner to monitor the quality of the completed construction product;

d. "Design Engineer" is defined as the authorized representative of the Owner, who has designed the facilities to be constructed and prepared the plans and specifications;

e. "Contractor" is defined as the party or parties which have a contract agreement with the Owner and perform the actual construction activities.

f. "Specifications" is defined as this document of technical specifications prepared by Steffen Robertson and Kirsten (U.S.), Inc. for the Barite Hill Project dated June, 1996;

g. All slopes are described in terms of horizontal distance: vertical distance; and

h. All sieve sizes refer to U.S. Standard sieve sizes.

1.4 Applicable Codes and Regulations

The work shall conform to applicable federal, state and local regulations. Test procedures shall conform to applicable ASTM standards, as documented in the edition of the standards in force at the start of work.

2.0 CONTRACTOR'S RESPONSIBILITY

The Contractor shall carefully examine all of the Technical Specifications, the Closure Report and the site of the work. He shall fully inform himself as to the character of all conditions at the site, local and otherwise, affecting the execution of the work, including those conditions to which federal, state and local safety and/or health laws and regulations may be applicable. Failure to comply with the requirements of this section shall not relieve the Contractor of responsibility for complete performance of the work.

It shall be the sole responsibility of the Contractor to familiarize himself, by such means as he considers appropriate, with all matters pertaining to this work including, but not limited to:

- The location and nature of work;
- Applicable safety and health regulations;
- Availability of utilities;
- Erosion control measures;
- Dust abatement requirements;
- Subsoil conditions;
- Geologic conditions at the site;
- Water source required for construction;
- Climatic conditions;
- The nature and conditions of the terrain;
- Transportation and communication facilities;
- Location, availability, and condition of construction materials;
- Selective borrowing within approved borrow areas;
- Other construction or mining activities at the project site that may be underway simultaneously with the construction work for these facilities; and

- All other factors that may affect the cost, duration, and execution of the work.

Prior to the start of the work, the Contractor shall prepare for the Owner a schedule outlining the Contractors proposed sequence of construction activities such that the Owner can coordinate other activities at the site. The Contractor's construction schedule must meet the Owner's approval.

The Contractor shall ensure that it, its subcontractors and suppliers and their respective employees, agents and invitees comply with all applicable governmental laws, rules, regulations, orders and directives concerning health and safety. The Contractor shall take all responsible measures to prevent injury to all persons and property as a result of performance of the work, including without limitation the furnishing, at the Contractor's expense, of fences, flagmen, warning signs and barricades and the elimination of excessive dust and smoke emissions. The Contractor shall develop, submit and maintain for the duration of the work, a safety program that will effectively incorporate and implement all required safety provisions. The Contractor shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program.

The Contractor shall store materials, confine his equipment, maintain construction operations and the operations of workmen to limits indicated by law, ordinances, permits, or requested by the Quality Assurance Inspector, Construction Manager or Owner, and shall not unreasonably encumber the premises with his materials. Caution shall be exercised at all times to avoid blocking access and haul roads or in any other way interfering with the Owner's activities or the activities of other contractors. The Contractor shall not, at any time, engage or instigate activities that would, in the Construction Manager's or Quality Assurance Inspector's opinion, present a hazard to personnel, or operations, or to the public.

The Contractor shall meet with the Construction Manager and Quality Assurance Inspector to establish the extent of the above areas, and any other area which may impact the schedule or method of performing the work, to accommodate the work activities in the required areas.

The Contractor shall at all times keep the work site neat, tidy and free of waste materials or rubbish resulting from his work. Fuel, lubricating oils and chemicals shall be stored and dispensed in such a manner as to prevent or contain spills and prevent said liquids from reaching local streams or groundwater.

Prior to demobilization, the Contractor shall remove all trash, debris and waste material from the site and properly dispose of said material. The Owner shall have the right to determine what is waste material or rubbish and the manner and place of disposal. All material furnished for the execution of the work and thereby purchased by the Owner shall remain the property of the Owner.

The Contractor shall clean out all installations and tear down and remove all temporary structures built by the Contractor. The Contractor shall leave the site area in a condition at least as good as the condition prior to construction. The Contractor shall also grade the construction site to provide proper drainage and give a sightly appearance. Any damage to existing facilities which does occur as a result of the Contractor's activities or employees shall be repaired at the sole expense of the Contractor.

The final condition of the construction site is subject to the approval of the Owner.

3.0 INSPECTION OF WORK

3.1 General

Unless otherwise specified, full-time inspection of all construction activities defined by the Specification will be provided by the Owner. Owner's inspection of all work shall be performed under the supervision and control of the Quality Assurance Inspector or his designated representative while such work is in progress. Said inspections are for the convenience, satisfaction, and benefit of the Owner in determining that the work is performed in strict accordance with the Specifications. The Quality Assurance Inspector will inspect, test and report all findings to the Construction Manager. The Construction Manager shall be responsible for enforcing the Specifications or initiating variances or design changes through the Design Engineer. Owner's inspections shall not relieve the Contractor of responsibility for the acceptability of the finished work or portions thereof.

3.2 Access

The Quality Assurance Inspector and his representatives shall at all times have access to the work whenever it is in preparation or progress provided that they report their presence to the Construction Manager who is responsible for all activities on-site. The Contractor shall fully cooperate with the Quality Assurance Inspector, shall provide proper facilities for access, and shall furnish labor and equipment reasonably needed for safe and convenient inspection. The Contractor shall give the Quality Assurance Inspector ample notice of readiness of the work for inspection, and the Quality Assurance Inspector shall perform said inspections in such a manner as not to unnecessarily delay the work.

3.3 Examination

If any work should be covered up without prior approval or consent of the Quality Assurance Inspector, it must, if required by the Quality Assurance Inspector, be uncovered for examination.

3.4 Samples and Tests

It is the intent of these Specifications that materials shall be inspected and tested by the Quality Assurance Inspector before final acceptance of the work. Any item of the work which is found not to meet or exceed the Specifications or which is improperly located or constructed shall be removed and replaced. The Quality Assurance Inspector's tests and inspections shall not relieve the Contractor from full responsibility to furnish and install materials in conformance with these Specifications.

Construction quality control testing shall be conducted by the Quality Assurance Inspector during the course of the construction activities unless otherwise indicated in these Specifications. Quality control testing shall consist of, but is not limited to, determination of moisture-density relationships for compaction control, agricultural soil analyses, and in situ hydraulic conductivity, moisture content and density determinations for cover materials. Unless otherwise indicated, test procedures shall conform to applicable ASTM standards, as documented in the edition of the standards in force at the start of work.

3.5 Alteration to Specifications

All alterations made to the Specifications shall be subject to the Design Engineer's approval and, where applicable, to the approval of governmental regulatory agencies. All alterations shall be issued under a covering work order signed by the Design Engineer.

APPENDIX F
QA/QC PROGRAM FOR COVER PLACEMENT

BARITE HILL PROJECT
QA/QC PROGRAM FOR
CLOSURE COVER MATERIAL

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1.0 GENERAL

This QA/QC Program has been prepared to outline the required inspection and testing for the Type 3 cover fill material placed during the closure of the Main Pit. The closure includes Phase 1, 2 and 3. This QA/QC Program shall be read in conjunction with "Barite Hill Project, Technical Specifications for Main Pit Closure" (SRK, 1996).

2.0 REGRADING OF PIT WALLS

Prior to the placement of any cap material, pit area shall be partially backfilled and regraded. The maximum allowable side slopes shall be 3H:1V. Verification of the surface preparation and slopes will be performed prior to placement of Type 3 fill.

3.0 COMPACTION OF TYPE 3 FOUNDATION

Prior to placement of the Type 3 fill over the completed surface of the Type 2 fill, the surface of the Type 2 fill shall be compacted. For materials with physical properties that are within the range of ASTM D698, the Type 2 fill shall be scarified to a depth of 12 inches and compacted to 95 percent of maximum dry density at plus or minus 5 percent of optimum moisture content as determined in accordance with ASTM D698. In situ moisture and density may be determined by nuclear gauge or sand cone methods.

For coarse materials outside the scope of ASTM D-698, the Type 2 fill shall be proof rolled with a loaded haul truck or suitable high contact pressure equipment. Areas exhibit pumping or excessive rutting shall be reworked and compacted, to the satisfaction of the Quality Assurance Inspector, to produce a stable foundation for Type 3 fill placement

Where materials meet the requirements of ASTM D698. field moisture/density testing of the compacted Type 3 foundation material shall be conducted at a minimum of one test per each 50,000 square feet (sf) of surface area.

Proof rolling tests shall be conducted at a frequency determined by the CQA Inspector.

4.0 COVER MATERIAL (Material Soil Type 3)

4.1 General

The cover material will be placed over the entire area of the backfilled and regraded pit. The material shall consist of fine grained soil obtained from the clay borrow area adjacent to the mine pit, or other borrow sources as approved by the CQA Inspector.

4.2 Conditioning and Placement

Cover material will be obtained from approved borrow sources, and moisture conditioned to within 5 percent of optimum moisture content as determined by ASTM D 698. Section 6.2.3 of the Technical Specifications will be followed during this portion of the work.

Moisture conditioned material imported as fill will be placed in 12-inch maximum loose lifts and compacted to at least 95 percent of maximum dry density at plus or minus 5 percent of optimum moisture content in accordance with ASTM D698.

Where suitable Type 3 fill material exists in place, the material shall be scarified to a depth of 12 inches and compacted to at least 95 percent of maximum dry density at plus or minus 5 percent of optimum moisture content in accordance with ASTM D698.

5.0 COMPACTION AND PERMEABILITY

BAT in situ permeability tests shall be performed on the completed cover thickness of 24 inches where the type 3 material is placed as fill, or on the completed 12-inch compacted thickness where Type 3 materials exist in place. The maximum allowable permeability shall be 5×10^{-6} cm/sec.

5.1 Testing Frequencies

Field moisture/density tests shall be performed on each compacted lift. A minimum of one test per every 50,000 sf of surface area shall be conducted to evaluate in-place moisture and density. Additional tests may be run at the discretion of the CQA Inspector. Moisture/density testing shall be performed by either sand cone (ASTM D-1556) or nuclear gauge (ASTM D 2922) methods.

In situ permeabilities shall be measured at a frequency of one test per every 50,000 sf of completed cover by the "BAT" probe method.

6.0 REPORTING

Test data will be tabulated and maintained at the site for inspection. Upon completion of pit closure activities, quality assurance testing data will be included in an as-built report prepared for agency submission and review.

7.0 FINAL INSPECTION

Upon completion of Type 3 cover fill material and topsoil placement, a walk through inspection of the reclaimed pit area will be conducted by the contractor, quality assurance inspector and responsible engineer. The results of the final inspection will be documented in the as-built report.